Part 2 of
combined temporary
teaching guide for

Seeing through arithmetic 2 (pages 109-215)

Seeing through arithmetic, Practice tablet 2 (pages 101-176)

Seeing through arithmetic 2, Workbook edition (pages 179-320)

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This is Part 2 of the Temporary Teaching Guide to accompany the hardbound *Seeing Through Arithmetic 2*, the *Seeing Through Arithmetic, Practice Tablet 2*, and the *Seeing Through Arithmetic 2, Workbook Edition*.

If you are using the hardbound *Seeing Through Arithmetic 2*, you will find teaching notes for each page in the pupil's book indicated by the letters *STA* followed by the page number. For example, *STA 2* page 111 indicates that the notes and directions are for page 111 of *Seeing Through Arithmetic 2*. If you are using *Practice Tablet 2* along with *Seeing Through Arithmetic 2*, directions for each page in the Practice Tablet will be labeled "Practice tablet" followed by the page number. For example, *Practice Tablet* page 102 means that the notes and directions are for page 102 of *Practice Tablet 2*.

If you are using the Workbook Edition, the directions and notes for each page will be labeled "Workbook edition" followed by the page number. For example, **Workbook edition** page 181 indicates that the notes and directions are for page 181 of *Seeing Through Arithmetic 2, Workbook Edition*.

ORDINAL USE OF THE COUNTING NUMBERS

Numbers are used not only to tell how many objects are in a set, but also to indicate a certain position within a set of ordered objects. To indicate a certain position within a set of ordered objects involves the ordinal use of number.

The cardinal use of number is used to express the result of counting, for example, to indicate that 12 books are on a table. When one counts the books, the final answer is the same, regardless of how the books are arranged when they are counted.

Suppose that the same 12 books are placed on a shelf, and that the ordinal use of number is used to indicate the position of a certain book with respect to the other books. Which book is first depends upon the starting point. The book that is "second" when the books are ordered from left to right will be "eleventh" when the books are ordered from right to left. Thus the position within a set of ordered objects is relative to a starting point.

Children need careful instruction and many experiences in using number names to identify, for a certain object, its position with respect to the other objects in the set. They must become aware that position is relative to a starting point and to the direction in which the "count" is made.

STA 2 page 109
Workbook edition page 179
Position within a set

The children learn to use a number to indicate the position of an object within a set of ordered objects. They also learn to use numerals and ordinal words (orally) to describe the position of this object.

Note that the same set of blocks is shown in each of pictures A through D. The pictures should be used for reteaching the following ideas: the ordinal words (first, second, and so on) describe a position; the position of a given object is relative to the starting point; the objects of a set may be ordered from left to right, from right to left, from bottom to top, and from top to bottom.

Pictures E through I suggest sets that have more than 10 members. These pictures should be used to introduce names of positions beyond the tenth position (eleventh, twelfth, and so on). Note that in pictures E, G, and H, the last member of the set is shown. However, in pictures F and I, the last member is not shown, and you do not know how many members are in the set. Use these two pictures (F and I) to help the children learn about positional meaning associated with numbers greater than 24.

Introduce the page by having the children study the whole page. Have them identify the objects in each picture. They should discover

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that the same set of blocks is shown in each of pictures A, B, C, and D.

Call attention to the numerals that appear on some of the blocks shown in picture A. Tell the children that a numeral on a block shows the position of the block in the set. Ask: "How many blocks are there? Which block is in position 1? Which block is in position 2? In which position is the blue block with the red marks (*Wkbk*, blue block with blue marks)?" Follow a similar procedure for identifying the position of each of the other blocks in the picture. Then call attention again to the block in position 1. Explain that, instead of saying that this block is in position 1, they can say that this block is *first*. In the same way, introduce orally the words *second* through *tenth*.

Use a similar procedure in discussing pictures B, C, and D. For picture D, for example, lead the children to observe that the block that was first in A and C is now tenth, that the block that was second is now ninth, and so forth.

For picture E, help the children discover that the ribbon (only partially visible) in the position before position 11 is in position 10, or is the tenth ribbon. Have the children use the words "eleventh" through "nineteenth" orally to describe the positions of the remaining ribbons.

For picture F, have the children identify the sixteenth balloon, the twenty-fifth balloon, and all the positions between these two. Explain that they do not know how many balloons there are in all. Suggest they imagine that there are 30 (or any other number) balloons. Have them give orally the name of each position within the set. Use a similar procedure for picture G.

Provide opportunities for the children to participate in activities in which it is necessary to describe the position of an object within a set.

Practice tablet page 101

Direct attention to Picture A. Say: "In which direction are you to count? [From left to right] Look at the response spaces. On each response space you are to write the numeral that tells what position the cup is in. Find the first response space. In which position is this cup? [Forty-fifth] What numeral should you write on this space? [45] Write 45 on the response space above this cup. On each of the other response spaces, write the numeral that tells what position the cup is in.

"For each of the other pictures, decide in which direction you are to count. Then, on each response space, write the numeral that tells what position the object is in."

ST4 2 page 110
Workbook edition page 180
Position within a set; use of a pair of numbers to indicate position

The children have learned how to describe the position of an object within a set of ordered objects. Now they learn to use a pair of numbers to describe the position of an object with respect to a given starting point. They also learn to describe the position of a certain letter of the alphabet.

Direct attention to the picture across the tops of pages 110 and 111 (*Wkbk*, pages 180 and 181). Be sure that the children notice that each block has two parts: the top part is for a letter of the alphabet; the bottom part for the numeral that describes the position of the letter. Ask: "In saying the alphabet, what letter is in the number 1 position? What other word can we use to describe this position? The letter B is in what position? What letter should be put on the third block? What position is the letter D in?" Continue a similar procedure for each of the other blocks. The purpose of this activity is to have the children understand that the letters of the alphabet occur in a certain order and

that a number can be used to describe the position of each letter. You should not expect the children to remember that the letter E is the fifth letter of the alphabet, that the tenth letter of the alphabet is the letter J, and so forth.

Do not attempt to complete all the work on this page in one class period. Even with the most able children it is wise to distribute the work over at least two, and possibly three, periods. It is important to keep in mind the objectives in teaching this page. The children are to learn the following: how to locate a position when it is necessary to start at a given point and count rows (down or up) and boxes (left or right) and to use numbers and directions (down, up, left, right) to describe a position. To do this they must learn to determine the position of each row of boxes, proceeding either from top to bottom or from bottom to top, and they also must learn to find a given box in a row, starting at either the left or the right side of the page.

The teaching procedures suggested above are for the situation in which the rows are ordered from top to bottom and the boxes are ordered from left to right. Adapt these suggestions for three other possible situations; that is, the rows ordered from bottom to top and the boxes from left to right; the rows ordered from top to bottom and the boxes from right to left; and the rows ordered from bottom to top and the boxes from right to left.

Call attention to the chart and have the children talk about the objects they see. Explain that each object is in a *box* and that the boxes are arranged in *rows*. Then proceed somewhat as follows: "Find the blue top with the red handle. This top is in row 1, or the first row. Now find the brown balloon. The balloon is also in the first row. What other objects are in the first row? [The spoon, the chicken, the pan, and the frog] What objects are in the second row? [The horse, the spool, the iron, the boxcar, the drum, and the table]"

Continue with similar questions and directions for each of the succeeding rows, going from top to bottom. Be sure to refer to each row by numeral and ordinal word (row 1 and first row, row 2 and second row, and so on).

Before proceeding to establish the position of the boxes, be sure that each child can distinguish his left hand from his right hand. Explain, if necessary, how the right side of the page can be distinguished from the left side. Then use questions and directions similar to the following: "Look again at the blue top with the red handle. What row is the top in? What other objects are in the first row? Are the top and the balloon in the same box? [No] The top is in the first box of the first row. Which box is the balloon in? [The third box] What object is in the fifth box? [The spoon] What box is the chicken in? [The sixth] What box is the pan in? [The eighth] What object is in the tenth box? [The frog] Which boxes in the first row are empty? [The second, the fourth, the seventh, and the ninth]" Proceed in a similar manner to describe the position of boxes in several other rows.

Pupils should understand clearly that there are 10 rows of boxes with 10 boxes in each row. They should also understand that the heavy gray lines shown in the chart separate row 5 from row 6 and separate the fifth row in each row from the sixth box in the row. This information is important, since it helps children orient themselves to the positions of the boxes and the rows without counting. Work with the children along these lines: "Alice, point to row 1. Peter, point to row 10. How many boxes are there in row 1, Alice? Peter, how many boxes are there in row 10? Who can tell us how many boxes there are in each of the 10 rows?

"Is there anything that will help you to tell row 6 from row 5? What is it? Is there anything that will help you to tell box 6 from box 5 in each row? What is it?

"Find row 1, box 5. Put your red marker in this box. Now look at box 5 in each of the other rows. Bob, tell us what objects are in each of these boxes. Anne, tell us what object is in box 6 in each row.

"Now, point to row 6. Tell us what objects are in row 5. Dorothy, do the same for row 2."

Proceed in this manner until the children can identify rows 2 and 5 and boxes 5 and 6 without hesitation. Once this knowledge has been achieved, their previous experience with positional number will help them determine the position of any row or box.

Next locate other rows in random order and identify various boxes in each row. Proceed somewhat as follows: "Find row 7 from the top. Find box 6 in row 7. What is in this box? Find the airplane. Which row is it in? Which box is it in? What is in row 7, box 6?"

Exercises similar to the following will help to round out the children's experiences with this page. "The turtle is in which row from the top? How can you tell what box it is in, starting from the left? Which row is the horse in? It is in which box? The block is in which row? It is in which box?

"George, find a picture that shows a mechanical toy you would like to have. Don't tell us what it is! Just tell us which row it is in and which box it is in. Who can tell us what George chose?" Let each child choose an object he would like to have and state its position. Then let other children decide which objects have been chosen.

Similar questions and directions should be used until the children can identify, without counting, each row from bottom to top. Similarly, they should also learn to identify each box going from right to left.

As a final activity, have the children notice that there are 11 rows of boxes above the row that the blue top is in. Thus, the box containing the blue top would be the eleventh box. Follow the procedures you have been using and have the children identify the box containing the blue top as the eleventh row, the next row as the twelfth row, and so on to the twentieth row. Have them locate various objects, such as the object in the thirteenth row, fifth box, and so on. It is suggested that, in identifying the elevento through twentieth rows, you have the children work only from top to bottom and from left to right. You could have the more able children consider the numbering in other ways.

ST4 2 page 141

Workbook edition page 101

Use of a pair of numbers to indicate position

The children continue to use a pair of numbers to indicate position.

The three blocks of exercises on this page are concerned with describing the positions of objects in the chart on page 140 (*table*, page 140). Introduce the printed words "row" and "box" before beginning work on this page.

For each exercise identified by a red letter, first designate which box is to be used as the starting point. Then have the children read the exercise silently, locate the box described, and tell what object is in this box. For example, in exercise A the children are to locate the object that is row 4, box 5. One procedure to use in having the children locate this box, could be similar to the following: "Use the box that contains the blue top as the starting point. The blue top is in row 1, box 1. Find row 4, box 5. What object is in this box? [The car] This time the starting point is the boat, as the boat is in row 1, box 1. Find row 4, box 5. What object is in this box? [The pail] Now the frog is the starting point, so the frog is in row 1, box 1. Find row 4, box 5. What object is in this box? [Nothing. It is an empty box.] What objects are in the boxes beside this empty box? [The car and the brush] Now the starting point is the bear, as the bear is in row 1, box 1. Find row 4, box 5. What object is in this box? [The bat]"

Another procedure that could be used is to complete all exercises in this block by using the box with the blue top as the starting point. Discuss each exercise again using the box with the boat as the starting point, then the box with the frog as a starting point, and finally the box with the bear as a starting point.

Adapt the procedures you have been using when you discuss the exercises identified by green letters (Wkbk, blue letters). It is suggested that you use only the blue top as the starting point.

Designate a starting point before working with the last block of exercises. Then have the children read the exercise, locate the object in the chart, and decide what numeral replaces each placeholder. Have various children read the completed exercise aloud.

After completing the exercises, call attention to the chart at the bottom of the page and have the children describe what they see. They should discover that the rows are identified by the letters A, B, C, D and that the boxes are indicated by numerals. Ask: "Which row do you think is the first row? [The row labeled A] Why do you think this is the first row? [The letter 'A' is the first letter of the alphabet.]" Discuss the labels of each of the other rows. The children should discover that the row labeled B is the second row, that the third row is labeled C, and that the fourth row is labeled D.

Next lead the children to discover that the first box is labeled 1, the second box 2, and so forth. After discussing the labels of the rows and boxes, ask: "What object is in row B, box 5? [The shovel] What is in row D, box 8? [The umbrella] Find the purse. What row is it in? [Row C] What box is it in? [Box 1]"

Continue this procedure until the children can locate any of the pictured objects with ease.

Workbook edition page 182

See the directions given for *Practice tablet* page 101.

Practice tablet page 102

Workbook edition page 183

Direct attention to Exercise A. Say: "You are to tell where the tin can is located in the chart. Find the tin can in the chart. In which row is the tin can? [Row C] Write the letter C on the response space after the word "row." In which box is the tin can? [Box 4] Write the numeral 4 on the response space after the word "box."

"For each of the other exercises, look at the object shown, and then find this object in the chart. On the response space after the word "row," write the letter that tells which row the object is in. On the response space after the word "box," write the numeral that tells which box the object is in."

Practice tablet page 103

Workbook edition page 184

Introduce the printed word *at*. Then direct attention to Exercise A. Have the children read Exercise A silently. Then say: "Where are you to begin? [At A] Put your finger on A. In which row are you to write the letter V? [Row 2] In which direction are you to count? [From top to bottom] Find Row 2. In which box are you to write the letter V? [Box 5] In which direction are you to count? [From left to right] Find the fifth box in Row 2. Trace the letter V.

"For each of the other exercises, read the directions given. Then write the letter named in the correct box."

BASIC FACTS

The addition and subtraction basic facts with sums and minuends greater than 10 and less than 19 have long been considered the "difficult" ones. It has been found that chil-

dren make many errors when they try to learn these basic facts by rote methods. It should be noted that the methods suggested in the *Seeing Through Arithmetic* program differ markedly from rote methods. The emphasis in this program is upon the use of objects and visual aids and upon the general principles consistent with modern theories of learning. These newer methods lead to better understanding and increased retention, in contrast to mere memorizing and rapid forgetting.

In the past, children have often memorized these so-called "higher decade basic facts" with little or no experience that related the facts to objects. Although objects or pictures were sometimes used, the experience was generally confined to counting. For example, if sets of 8 and 5 were to be combined, the child was told to start with the set of 8 and continue the counting with the members of the set of 5, saying, "nine, ten, eleven, twelve, thirteen." No direct use was made of the principles of the numeration system or of the idea of reorganizing the numbers of the sets. To provide greater continuity and sequence in the organization of the learning experiences, these ideas and principles should be introduced and used explicitly.

If a set of 8 and a set of 5 are to be combined, the total set can be reorganized into a set of 10 and a set of 3. To adults, who know that 8 + 5 = 13, this statement may appear to be obvious and trivial. To the child, who is learning the fact for the first time, it is not so simple. He can be helped to see and understand it if he is shown how 2 objects from the set of 5 objects are combined with the set of 8 objects to make a set of 10 objects. The set of 10 objects and the set of 3 objects that remain are then seen as 13. In this way, a principle of the numeration system is put to use.

The child should also have experience in determining the number of objects in a set that has from 11 through 18 members. He can do this by finding a set of 10, determining the number of items that cannot be grouped as 10, and thus getting the name of the number associated with the total set. He can make use of this idea to determine, without counting, the number associated with the original set in situations that are used to teach the subtraction basic facts with minuends from 11 through 18.

Note that in *Seeing Through Arithmetic 2* the same general methods are used to present the basic facts for all members greater than 10 (11 through 18). Note also that, when work on these basic facts has been completed, all of the addition and subtraction basic facts have been introduced.

STA 2 page 112
Workbook edition page 185
Recognition of the numerousness of sets by grouping

The children learn to group objects of sets that have from 11 through 18 members into tens and ones as preparation for learning the basic facts for numbers greater than 10.

This lesson provides the children with experiences in recognizing a set of 10 within a larger set containing as many as 18 objects. When they see the total set as made up of a set of 10 and several ones, they can easily determine how many objects there are in all without counting. Principles of the numeration system already learned (grouping by tens and ones) are used with the work on these pages.

Children will benefit greatly from experiences in recognizing the numerousness of sets of objects. Give them as much practice with this activity as possible. The children can work in small groups or in pairs. Have one child place on a table sets of 11 through 18 small objects (jacks, bottle caps, etc.). Have another child place a string around ten of the objects (in the book a ring is drawn around ten objects). The "grouping" of a set of ten will help the children determine how many objects there are in all. Let children

take turns showing how each "sees" the set of ten.

You can also use an overhead projector to good advantage here. Place a projection screen at the front of the classroom. Then, on the projection plate of the projector, place sets of objects (jacks, small disks, etc.). Ask one of the children to show a grouping of ten by placing a piece of string on the projection plate. The silhouette projected on the screen will be visible to all the children in the class.

Each sequence of pictures shows the children how to approach the reorganization of objects for easy recognition of the numerousness of the set. The first picture of each pair shows a set of objects (more than 10) that have not been grouped. The second picture shows the set of objects grouped as 1 ten and a number of single objects, thus permitting rapid identification of the number of objects as 1 ten and some ones.

Before beginning work with the pictures on this page, review with the children the ideas that 14 means 1 ten 4 ones, that 18 means 1 ten 8 ones, and so on.

Then have the children look at Picture A. Ask: "Do you think that there are more than 10 jacks in picture A? We need to find a way to group these jacks so that it will be easier to find how many there are."

Ask the children to look at picture B. Get them to see that a ring has been drawn around 10 of the jacks. Ask how many jacks are outside the ring. Ask them to name the number represented by 1 ten 5 ones. The children should know from their previous study of the numeration system that it is fifteen.

Tell the children to look again at picture A and to suggest different ways of showing a set of 10. Some can show a set of 10 by tracing a ring with their fingers. The children can also show a set of 10 by holding a small card or piece of paper on its edge between a set of 10 objects and the other objects. Check to see that they are doing the work correctly. Bear in mind that not all children will see a set of 10 in the same way.

Follow a similar procedure for the other pairs of pictures on this page.

STA 2 page 118

Recognition of the numerousness of sets by grouping

The children continue to group objects of sets that have from 11 to 18 members into tens and ones as preparation for learning the basic facts for numbers greater than 10.

Page 118 continues the techniques begun on page 112. Each of pictures A through I shows a set of objects that can be organized as 1 ten and some ones.

If convenient, give each child a piece of transparent paper (clear acetate may be used) to fasten over page 118 in his book. Provide paper clips, and show the children how to fasten the transparent paper so that it will be held securely.

For each picture, direct the children to cover a set of 10 with their fingers. Encourage them to note the number of objects that are not in the grouping of ten. Then, using a crayon and the transparent paper placed over page 118, have them draw a ring around a group of 10. Then tell them to write on the paper the numeral representing the total number of objects. For picture A, they should discover that the total number of objects is 16. Finally, have one child give orally the number that is associated with the set of objects.

For additional practice in grouping sets of 11 through 18 objects, children can work in pairs on activities such as the following: Give each group of children 18 objects and a large sheet of paper divided into eight sections. One child drops a handful of objects upon a section of the paper. Another child draws a ring around 10 of the objects to enable him to see quickly how many there are in all.

Structure tablet page 3-4

Workbook edition page 186

Direct attention to Picture A. Say: "You are to find out how many dots there are in this picture. Draw a ring around each group of 10 dots. How many groups of 10 dots are there? (i) How many single dots are there? (ii) How many dots are there all together? (iii) Write it in the response space."

For each of the other pictures, first have a ring around each group of 10 objects. Then in the response space, write the numeral that tells how many objects there are."

STM 2 pages 116

Workbook edition page 187

Basic fact: Sums and minuends of 11

The children begin to study the basic facts with sums and minuends of 11.

The children have already learned the basic facts with sums and minuends of 9 through 10. In studying these facts, they used pictures that showed sets of objects being put together or separated, and they carried out actions that put together or separated actual objects. [illegible]

For the basic facts with sums and minuends of 11 through 18, the children work with verbal problems, each illustrated by a two-scene picture. The first scene of each picture illustrates the action described by the verbal problem. The second scene shows the set that results from the action.

A comment should be made here as to the commonly accepted definition of a basic fact. If a mathematical sentence expresses a basic fact, two of the three numerals in the sentence *must* be one-digit numerals. Thus the sentence $9 + 3 = 12$ satisfies this requirement, but the sentence $12 - 3 = 9$ does not, and therefore does not express a basic fact.

In presenting the basic facts for numbers greater than 10, the idea of grouping objects as one ten and some ones is again used. As a result, [illegible] a ring is shown around ten objects [illegible]

counting, a ten and the extra ones and then recognize the total easily.

First, have the children look at the page as a whole and identify the objects. Next, direct attention to the problem in picture A and have the children read the problem silently. Then introduce the problem by giving instructions and asking questions similar to the following: "Read the first sentence in the problem. Now look at the first scene. Which set of dolls shows the dolls that Jan had? Read the second sentence. How does the picture show that she was given 9 more dolls? Now read the third sentence. What are you asked to find? Look at the second scene in the picture. Can you tell, without counting, how many dolls there are? What do you see in the picture that helps you find how many dolls there are in all? Cover the set of 11 dolls with your hand. Look at the sentence $9 + 2 = \blacksquare$. This sentence describes the problem situation. What does the 9 stand for? [illegible] in the sentence? What does the 2 tell? Why is the symbol for addition used? What does the placeholder represent? Now look at the picture again. How many dolls are there after she was given the 9? What numeral replaces the placeholder? Is the last sentence correct? Billy, read it aloud."

If necessary, have the children use markers to illustrate the problem situation. Be sure they understand that 9 + 2 and 11 are names for the same number and that 11 is the standard name for this number.

Follow a similar procedure for pictures B, C, and D.

After all the pictures have been discussed, have the children use their numeral and symbol cards to build and complete sentences that you describe. For example, you might say "Subtract 8 from 11." The children would first build the sentence $11 - 8 = \blacksquare$ and then replace the placeholder by the numeral 3 to get $11 - 8 = 3$. Provide opportunities for the children to [illegible] giving them such sentences as "Add 9 to 7."

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"Nine minus three is equal to what number?" and "Six plus two is equal to what number?"

STA 2 page 115
Workbook edition page 188
Basic facts: sums and minuends of 11

The children continue to study the basic facts with sums and minuends of 11.

On this page, four more of the basic facts with sums and minuends of 11 are taught by use of verbal problems and pictures. For each picture, a ring is used to identify a set of 10, thus making it easy for the children to name the total quickly.

Introduce the page by having the children look at the page as a whole and identify the objects. Procedures given for page 114 (Wkbk, page 187) may be adapted for this page.

STA 2 page 116
Workbook edition page 189
Basic facts: sums and minuends of 11

The children continue to learn basic facts with sums and minuends of 11.

On this page four more of the basic facts with sums and minuends of 11 are presented. Each basic fact is introduced in connection with a problem-solving situation. For each basic fact a two-scene picture shows the action and the set resulting from the action. The ring around a set of 10 is used to make recognition of the total number of objects easy.

The teaching suggestions given for page 114 (Wkbk, page 187) may be adapted for this page.

STA 2 page 117
Workbook edition page 190
Basic facts: sums and minuends of 11

The children continue to learn basic facts with sums and minuends of 11.

On this page four more of the basic facts with sums and minuends of 11 are presented. Each basic fact is introduced in connection with a problem-solving situation.

The teaching suggestions given for page 114 (Wkbk, page 187) may be adapted for this page.

STA 2 page 118
Keeping skillful: situations involving additive and subtractive action -- sentences of the forms $3 + 2 = \square$ *and* $6 - 4 = \square$ *; sums and minuends through 11*

The children analyze verbal problems that involve either additive action or subtractive action. They write number sentences that relate to the problem situation and use the sentences to help them solve the problem. They practice the addition and subtraction basic facts that they have studied so far.

Caution the class not to give the answer to the question asked in a problem immediately, even though they may know the answer. Explain that they are first to think of the number sentence that tells what is happening in the problem situation. Explain that later problems will be harder, and that they may not always be able to give an answer immediately. For these harder problems it will help them to know how to write the sentence that describes the problem situation.

Work through problem A with the children orally. As they build the number sentence for the problem, be sure they understand what each numeral and symbol in the sentence stands for. Ask questions similar to these: "How many blocks did John have? How many blocks did his brother give him? Is the action in this problem a combining action or a separating action? How do you know? What is the first numeral you should write in your sentence? What symbol should you write to show that the action is a combining action? How many blocks did John's brother give him? Where should you put this numeral? What sign should you write to complete the number sentence for this problem? What does the square screen in the number sentence stand for?"

Write the sentence containing a square screen on the chalkboard. Ask a child to rewrite the sentence on the chalkboard and supply the missing numeral. Some of the children may still need to use objects to help them under-

stand how to find the replacement for the square screen.

Have the children solve each of the other problems by writing two sentences: the first one with a screen in place of the missing numeral; the second with the missing numeral inserted. For problem B, they should write:

B 11 − 7 = ■ 11 − 7 = 4

For the two blocks of exercises at the right (green letters A through L and red letters A through M), have the children decide what numeral replaces each placeholder and write the completed sentence on their papers. For exercise A (green letter), they should write:

Green A 11 − 6 = 6

Go through the problems and exercises with the children, so that they may verify their sentences.

As an added exercise, have the children read each problem silently and find in the list of sentences labeled with green letters the sentence that relates to the problem (problem A, sentence H; problem B, sentence E; etc.)

STA 2 page 110

Keeping skillful: situations involving additive and subtractive action — sentences of the forms 3 + 2 = ■ and 6 − 4 = ■ ; sums and minuends through 11

The children analyze verbal problems that involve either additive action or subtractive action. They write number sentences that relate to the problem-solving situations and use the sentences to help them solve the problems. They practice the addition and subtraction basic facts that they have studied thus far.

The teaching suggestions given for page 110 may be adapted to this page.

Practice tablet page 105

Workbook edition page 191

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

Practice tablet page 106

Workbook edition page 192

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

STA 2 page 111

Workbook edition page 193

Basic facts: sums and minuends of 12

The children begin to study the basic facts with sums and minuends of 12.

On this page the addition and subtraction basic facts with sums and minuends of 12 are introduced. Each of four basic facts is pre-

sented in connection with a problem situation. A two-scene picture for each fact shows the action and the set resulting from the action. The ring around a set of 10 is used to make recognition of the total number of objects easier.

The teaching suggestions given for page 114 (Wkbk, page 187) may be adapted to this page.

STA 2 page 121
Workbook edition page 194
Basic facts: sums and minuends of 12

The children continue to study the basic facts with sums and minuends of 12.

On this page four more basic facts with sums and minuends of 12 are presented. Each basic fact is introduced in connection with a problem-solving situation.

The teaching suggestions given for page 114 (Wkbk, page 187) may be adapted for this page.

STA 2 page 122
Workbook edition page 195
Basic facts: sums and minuends of 12

The children continue to study the basic facts with sums and minuends of 12.

The teaching suggestions given for page 114 (Wkbk, page 187) may be adapted for the basic facts introduced on this page.

STA 2 page 123
Workbook edition page 196
Keeping skillful: situations involving additive and subtractive action -- sentences of the forms 3 + 2 = ▥ and 6 - 4 = ▥ ; sums and minuends through 12

The children continue to study the basic facts with sums and minuends of 12.

The teaching suggestions given for page 114 (Wkbk, page 187) may be adapted to introduce the basic facts in Pictures A and B.

The children then analyze and solve verbal problems that involve either additive action or subtractive action. They practice the basic facts they have studied.

The teaching suggestions given for *STA 2* page 118 may be adapted for this page.

STA 2 page 124
Keeping skillful: situations involving additive and subtractive action -- sentences of the forms 3 + 2 = ▥ and 6 - 4 = ▥ ; sums and minuends through 12

The children analyze and solve verbal problems that involve either additive action or subtractive action. They practice the basic facts they have studied.

The teaching suggestions given for *STA 2* page 118 may be adapted for this page.

Practice tablet page 107
Workbook edition page 197

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

Practice tablet page 108
Workbook edition page 198

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the

sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through Y. Say: "You are to complete each exercise by writing the correct numeral in the response space."

Practice Tablet page 109
Workbook edition page 105

Say: "Look at Picture A. Pretend that these coins are yours. Count your money. How much money do you have? (47¢) Write 47 on the response space.

"For each of the other pictures, count your money. On the response space write the numeral that tells how much money you have."

Practice Tablet page 110
Workbook edition page 106

Notice that this page consists of two blocks of exercises. Use your own judgment as to how many of these exercises you can assign at one time.

Tell the children that they are to complete each of the exercises by writing the correct numeral on a response space.

PROBLEM SOLVING

For the most part, the problems of everyday life that require an arithmetical solution fit rather certain frameworks. Some involve addition and are solved by addition. Others involve subtractive action and are solved by subtraction. Generally, these types are readily solved and children have little trouble with them.

Children do have difficulty, though, with those types of problems in which the action does not indicate the process used in finding the solution. As examples, there are several types of problems in which the action is additive, but the solution is found by subtraction. Problems of this type may be expressed by sentences of the forms ■ + 8 = 15 and 9 + ■ = 15. Also, there are types of problems in which the action is subtractive, but the solution is found by addition. Problems of this type may be expressed by sentences of the form ■ − 8 = 7. It is well, for teaching purposes, to give special attention to these problem types and to help the children learn why a process that differs from that indicated by the action is necessary to find the solution. This understanding can be achieved by means of concrete work with objects and the use of pictures.

Only two of these special types of problems are considered in *Seeing Through Arithmetic 2*. First, the children study situations that are expressed by sentences of the form ■ + 4 = 9. In these situations the action is additive, but the solution must be found by subtraction. Then the children study situations that are expressed by sentences of the form ■ − 4 = 5. In these situations, the action is subtractive, but the solution must be found by addition.

The authors selected these two special types of problems because they felt that children in grade 2 could more easily understand these types of problems than they could other types. These two special types of problems are considered below.

In many problem situations the question to be answered is "How many were there to begin with?" Suppose, for example, the child is asked to solve the following problem: "Tom had some blocks. Bob gave him 5 more. Then Tom had 7 blocks. How many blocks did Tom have to begin with?"

When situations of this type are analyzed, it is found that one set is put with another set. Therefore, the action on the problem is additive, and the sentence that expresses the problem situation must contain the symbol associated with additive action, namely, the symbol for plus.

It cannot be emphasized too strongly that the action involved in this kind of problem is the combining or additive type. Difficulty arises, however, because the number associated with the original set is unknown. The problem situation, when represented by symbols, cannot be solved directly by addition. When the numbers involved in a situation are not very great, as in the problem given above about the blocks, the answer comes to the mind of most adults so easily that the basic difficulty in the general situation may not be fully recognized.

Heretofore, when children have encountered problems of this type, it has been customary to tell them to "subtract the little number from the big one." Through constant drill upon problems of the same general type, some children learn to solve such problems. This is true in spite of the fact that the action is clearly additive and the process used to determine the solution for the problem is subtraction. Thus, in most cases in traditional programs, children have not been helped to understand why subtraction is used to solve problems of this type.

Consider again the problem about the blocks. First, the child must discover that he does not know how many blocks Tom had to begin with. Therefore, in building the mathematical sentence that expresses the problem situation, he should decide that a placeholder (▥) must be used to represent the number associated with the set of blocks Tom had to begin with. Next he should observe that Bob gave Tom 3 more blocks. To describe this action, he uses "+" in building the sentence, and he uses "3" to show how many blocks Bob gave Tom. At this point, the child has the phrase ▥ + 3. In this case, the phrase ▥ + 3 represents the number associated with the set of blocks Tom had in all. Finally he observes that Tom had 7 blocks in all. He knows that, since " ▥ + 3" and "7" are names for the same number, he can write the sentence ▥ + 3 = 7.

To find the replacement for the placeholder, the child needs to learn what to do with the 3 and the 7. He should note that he cannot add because he does not know one of the numbers to be added. However, through the use of objects and pictures, he learns that he can remove (or imagine being removed) a set of 3 blocks (the blocks Bob gave Tom) from the set of blocks Tom had in all. This action of removing the objects that were added restores the situation to what it was in the beginning. Through experiences such as this, the child learns in a meaningful way why he can *subtract* 3 from 7 to find the number of blocks Tom had to begin with.

The second new type of problem that the children study also involves the question "How many were there to begin with?" The following problem is an example of this type: "Some apples were in a box. Susan took 2 of them away. Then 3 apples were in the box. How many apples were in the box before Susan took 2 of them?"

When situations of this type are analyzed, it is found that some members of the set are removed. Therefore, the action is subtractive, and the sentence that expresses the situation must contain the symbol associated with subtractive action, namely, the symbol for minus.

The children learn to build the sentence ▥ − 2 = 3 to express the problem situation concerning the apples. In this sentence, the placeholder holds a place for the numeral that expresses the number of apples that were in the box to begin with; the "−" shows that some of the apples were removed; the "2" shows how many apples were removed; the "=" expresses the fact that the phrase ▥ − 2 and the numeral 3 are names for the same number; and the "3" shows how many apples were in the box after Susan removed 2 of them.

To find the replacement for the placeholder in ▥ − 2 = 3, the children must learn what to do with the 2 and the 3. They should discover that they cannot subtract because they do not know how many apples there were to begin with. Through use of objects and pictures, they learn that they can imagine that the 2 apples Susan

took away are put back with the 6 apples left in the box. This action of putting back the apples restores the situation to what it was in the beginning. Thus, the children learn in a meaningful way why they *add* 6 to 2 to find how many apples were in the box before Susan took 6 of them away.

ST4 2 page 105

Workbook edition page 201

Problem solving: additive action — sentences of the form ■ + 2 = 5

The children use pictures to interpret a verbal problem involving additive action. In this situation they must find the number of objects there were to begin with when the number added and the total number are known. They learn to express the problem situation by writing a mathematical sentence, and they use this sentence to help them find the number that answers the question asked in the problem.

Use Pictures A, B, C and D to help the children build the sentence that expresses the problem situation. Use Pictures E, F, G, H and I to help them find the number that answers the question and to help them understand why subtraction is used to find this number.

Have the children read silently the problem labeled A. Then ask a child to read the problem aloud. Direct attention to picture B. Say: "The box contains the blocks that Tom had to begin with. Do you know how many blocks Tom had to begin with?" *We are going to build a mathematical sentence for problem A.* Read the sentence below the picture of the box. Now look at the square screen. Why do we use this symbol to start our sentence? [Because we do not know how many blocks Tom had.]

Direct attention to picture C and have the children describe what they see. Ask: "The picture shows which sentence in the problem?" [Bob gave him 3 more.] Why do we use the + sign for plus in our sentences?" [To show that the action is a joining action.] Why do we use the numeral 3? [To tell how many blocks Bob gave Tom.]

Next call attention to picture D. Lead the children to discover that the picture shows the blocks Tom had after Bob gave him 3 more blocks. They should discover that the pictured situation relates to the sentence "Then Tom had 7 blocks." Then have the children study the mathematical sentence. Say: "Why do we use the numeral 7 in our sentence?" [To tell that Tom had 7 blocks in all.] What symbol in the sentence tells you that 'What number plus three' and 'seven' are names for the same number? [The symbol for 'equal to'.] Ask various children to read the mathematical sentence aloud. Discuss again each symbol and numeral used in the sentence to ensure that the children understand what it means. Be sure the children understand that the sentence ■ + 3 = 7 expresses the problem situation.

Continue to emphasize the importance of writing the sentence. Remind the children that later the problems will be more difficult and they will then not know the answer immediately. Knowing how to build and write mathematical sentences will be helpful in solving the more difficult problems.

Lead the children to conclude that the next thing they must do is to find the replacement for the square screen. Say: "Look at picture E. What does this picture show?" [The blocks Tom had after Bob gave him 3.] Look at picture F. Are these the same blocks that were shown in E? [Yes.] How many blocks did Bob give Tom? [3.] How many blocks are shown inside the ring? [3.] What do you think the blocks inside the ring represent?" [The blocks Bob gave to Tom.] What is happening in picture G? [A hand is pushing away the blocks that were shown inside the ring.] The hand is pushing the 3 blocks away because we want to know how many blocks Tom had *before* Bob gave him the 3 blocks. Is the action in the picture a separating action? What word do we use with the numerals when the action is a separating action? [Minus.] Does

'7 minus 3' tell what is happening? Does anyone know another word that we can use with this situation? [Subtract]"

Introduce the printed word "subtract" and have both sentences in picture G read aloud. Ask: "Does 'Subtract 3 from 7' also tell what is happening in picture G?"

Refer to picture H. Ask: "How many blocks are shown in picture H? Is '4' the standard name for '7 - 3'? Do you think that Tom had 4 blocks to begin with?"

Direct attention to picture I. Have the children describe what they see and read each sentence in the picture. They should observe that the screen has been replaced by the numeral 4. Ask: "How do you know that the numeral 4 replaces the placeholder? [Because 4 plus 3 is equal to 7] Do we use the number 4 to answer the question?"

Again have a child read the verbal problem aloud. Then have another child give the mathematical sentence that expresses the problem. Ask a third child to give the answer to the problem.

Provide each child with a set of about 12 markers and a set of cards that he can use to build mathematical sentences.

As another activity, have the children reread the problem and use their cards to build the sentence ▮ + 3 = 7. Be sure they can explain why the screen comes first in the sentence. Then have the children use their markers to reproduce the "undoing" of the action. Get them to understand that *any* set of 3 markers will do. When they have removed three markers from seven markers and have concluded that Tom had 4 blocks to begin with, ask: "How could you answer the question asked in the problem if you had no pictures or markers to help you?" The children should say that they would subtract 3 from 7.

STA 2 page 126
Workbook edition page 202
Problem solving: additive action — sentences of the form ▮ + 2 = 5

The children analyze another verbal problem involving additive action. In this situation also they must find the number to begin with when the number added and the total number are known. They build the mathematical sentence that expresses the situation and use this sentence to help find the number that answers the question asked.

The teaching suggestions given for page 125 (Wkbk, page 201) may be adapted for this page. Note that for pictures G and I the children are to decide what numeral replaces each placeholder.

STA 2 page 127
Workbook edition page 203
Problem solving: additive action -- sentences of the form ▮ + 2 = 5

The children continue to analyze verbal problems that may be expressed by sentences of the form ▮ + 2 = 5.

Tell the children to read silently the problem given in picture A. Have them look at the first scene. Ask them to describe what they see and to decide which sentences in the problem are related to this scene.

Follow a similar procedure for the second scene. The children should discover that the second scene illustrates the third sentence in the problem. [Then Ann had 8 jacks.]

Then have the children study the sentences below the verbal problem. Write " ▮ + 3 = 8" on the chalkboard. Ask: "Is this the correct sentence for the problem? What does the placeholder stand for? [The number of jacks Ann had to begin with] What does the '+' tell you? [That the action in the problem is a joining action] What does the numeral '3' tell you? [How many jacks Linda gave Ann] What does the numeral '8' tell you? [How many jacks Ann had after Linda gave her 3 more jacks] Why is '='

...ces in the sentence? (Because ■ + 3 = 8 and 5 + 3 = 8 are cases for the same number) How do we find the number of cubes Erin has to begin with? (by subtracting 3 from 8)

Call attention to the sentence "Subtract ■ from 8." Ask: "What number must we subtract from 8?" What numeral replaces the placeholder? Subtract 3 from 8. What number do you get?

Now refer again to the sentence ■ + 3 = 8, which you have written on the chalkboard. Ask the children to name the number that replaces the square. Write the sentence 5 + 3 = 8 on the chalkboard. Have various children read the sentences.

Lead the children to discover that the number 5 answers the question asked in the problem. Have one child read the problem. Have another child give the answer to the question asked. [Ann had 5 jacks before Lenda gave her 3 more.]

Work with the story problems in pictures B, C, and D in a similar way. For problems C and D have the children give orally the sentences "Subtract 3 from 9" and "Subtract 4 from 6." Then have them use their cards to build these sentences at their desks. Also have them use their cards to build the sentences 5 + ■ = 7 and 2 + ■ = 6.

STA 2 page 109

Problem solving: additive action — sentences of the form ■ + 2 = 5

The children continue to analyze verbal problems that may be expressed by sentences of the form ■ + 2 = 5.

Keep the teaching procedures given for page 108. Have the children read each problem and illustrate the problem with the help of the accompanying picture. Then have them write on paper or build with cards the mathematical sentence that "fits" the problem. This sentence should contain a placeholder.

Next, have the children give the sentence that tells what computation is performed ("Subtract 3 from 8" for the first problem). Then have them write or build the sentence again, this time with the numeral that replaces the placeholder. Finally, ask the children to answer the question asked in the problem.

Practice tablet page 111

Workbook edition page 50:

Say: "Read each problem carefully and study the picture that goes with it. Next, in the first response space, write the sentence that describes the problem. Be sure to use a square to hold the place for the number you are to find. Then, in the second response space, write the sentence with the numeral that replaces the square."

STA 2 page 109

Keeping skillful: problems expressed by sentences of the form ■ + ? = 5, 3 + ? = ■, *and* 6 − 4 = ■; *addition and subtraction basic facts*

The children apply the methods they have been studying to find the solutions of problems that involve either additive action or subtractive action. The problems on this page are expressed by sentences of the forms ■ + 3 = 5, 2 + 5 = ■, and 6 − 4 = ■.

If possible, have the children complete the work for the verbal problems independently. As a preliminary activity, you may wish to go through the problems orally with the children. Then have them read each problem, write the letter that identifies it on their paper, and for each problem write the following: a sentence that expresses the problem situation (the sentence should contain a placeholder); a sentence that tells what computation is performed ("Subtract 4 from 9" for problem A); a sentence that expresses the problem situation with a numeral instead of a placeholder; and a sentence that answers the question asked in the problem.

Have children who cannot complete the work for the verbal problems on this page independently use markers to illustrate the action in each problem.

Use the two blocks of exercises at the right of the page (blue letters A through L and red letters A through M) to reinforce the children's learning of basic skills. Also, have the children relate the sentences in the first block of exercises to the story problems on this page to strengthen their understanding of problem-solving procedures (sentence F relates to problem A, and so on). These blocks of exercises may be discussed orally, or they may be assigned as written work.

Practice tablet page 112
Workbook edition page 205

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

Practice tablet page 113
Workbook edition page 206

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

STA 2 page 130
Workbook edition page 207

Problem solving: subtractive action -- sentences of the form ▩ − 4 = 2

The children use pictures to interpret a verbal problem involving subtractive action. In this situation, they must find the number to begin with when the number subtracted and the number resulting are known. They express the problem situation with a mathematical sentence and use this sentence to help find the number that answers the question asked in the problem.

Use Pictures A, B, C, and D to help the children build the sentence that expresses the problem situation. Use Pictures E, F, G, H, and I to help them find the number that answers the question and to help them understand why addition is used to find this number.

Have the children read silently the problem labeled A. Then ask a child to read the problem aloud. Direct attention to picture B. Say: "What do you think was in the box? [Some apples] Do you know how many apples were in the box? We are going to build a mathematical sentence for problem A. How can we start our sentence?"

The children should be able to explain that a placeholder should be used because the number of apples in the box is not known. However, if the children do not understand how to use the placeholder, refer again to picture B. Say: "Read the sentence below the picture of the box. Now look at the screen. Why do we use this symbol to start our sentence?"

Direct attention to picture C and have the children describe what they see. Ask: "This picture shows which sentence in the problem? Why do we use minus in our sentence? Why do we use the numeral 2?" (The children should understand that the symbol "−" is used when some members of the set were taken away and that the numeral "2" tells how many apples Susan took away.

Next call attention to picture D. Lead the children to discover that the picture shows the apples that were in the box after Susan took 2 apples away. They should discover that the pictured situation relates to the sentence "Then 5 apples were in the box." Then have the children study the mathematical sentence. Say: "Why do we use the numeral 3 in our sentence? What symbol in the sentence tells you that 'what number minus two' and the numeral 3 are named for the same number?"

Ask various children to read the mathematical sentence aloud. Discuss again the symbols and numerals in the sentence to ensure that the children understand what they mean. Be sure the children understand that " ■ − 2 = 3" expresses the problem situation.

Lead the children to conclude that the next thing they must do is to find the replacement for the screen. Say: "Look at picture E. What does this picture show?" [The apples that were left in the box] Look at picture F. How is this picture different from picture E?" [There are two sets of apples, a set of 3 and a set of 2.] "How many apples did Susan take away?" [2] What do you think the set of 2 apples shows? [The apples Susan took away] What is happening in picture G? The hand is pushing the 2 apples toward the 3 apples because we want to know how many apples were in the box to begin with. Is the action in the picture a joining action? What word do we use with the numerals when the action is a joining action? [Plus] Does '3 plus 2' tell what is happening in picture G? What is another word we can use with this situation?" [Add]"

Introduce the printed word "add" and have both sentences in picture G read aloud. Ask: "Does 'Add 2 to 3' also tell what is happening in picture G?"

Refer to picture H. Ask: "How many apples are shown in picture H? Is '5' the standard name for '3 + 2'? Do you think there were 5 apples in the box to begin with?"

Direct attention to picture I. Have the children describe what they see and read each sentence in the picture. Ask: "What numeral replaces the screen? How do you know that the numeral 5 replaces the screen?" [Because 5 − 2 is equal to 3] "Do we use the number 5 to answer the question asked in the problem?"

Again have a child read the verbal problem aloud. Then have another child give the mathematical sentence that expresses the problem. Ask a third child to give the answer to the problem.

Provide each child with a set of about 12 markers and a set of cards that he can use to build mathematical sentences.

As another activity, tell the children to reread the problem and use their cards to build the sentence ■ − 2 = 3. Be sure they can explain why the screen comes first in the sentence. Then have the children use their markers to demonstrate the action of reproducing the original group. When they have combined 2 markers with 3 markers and have found that there were 5 apples in the box before 2 were removed, ask: "How could you answer the question asked in the problem if you had no pictures or markers to help you?" The children should say that they would add 2 to 3.

STA 2 page 191
Workbook edition page 808
Problem solving: Subtractive action — sentences of the form ■ − 4 = 2

The children analyze another verbal problem that involves subtractive action. In this situation they must again find the number to begin with when the number subtracted and the number resulting are known. They build the

mathematical sentence that expresses the situation and use this sentence to help find the number that answers the question asked in the problem.

The teaching suggestions given for page 130 (Wkbk, page 207) may be adapted for this page. Note that for Picture G, the children are to decide what numeral replaces each screen.

STA 2 page 132
Workbook edition page 209
Problem solving: subtractive action -- sentences of the form ▥ − 4 = 2

The children continue to analyze verbal problems that may be expressed by sentences of the form ▥ − 4 = 2.

Tell the children to read silently the problem given in picture A. Have them look at the first scene and describe what they see. Then have them decide which sentences in the problem are related to this scene.

Follow a similar procedure for the second scene. The children should discover that the second scene illustrates the third sentence in the problem. [Then she had 2 dimes left.]

Then have the children study the sentences below the verbal problem. Write " ▥ − 6 = 2" on the chalkboard. Ask: "Is this the correct sentence for the problem? What does the placeholder stand for? [The number of dimes Jane had to begin with] Why is the minus sign used in the sentence for this problem? [The action in the problem is a separating action.] What does the numeral 6 tell you? [How many dimes Jane used to buy a horn] What does the numeral 2 tell you? [How many dimes Jane had left] Why is '=' used in the sentence? [Because ▥ − 6 and 2 are names for the same number] How do we find the number of dimes Jane had to begin with? [By adding 6 to 2]"

Call attention to the sentence "Add ▥ to 2." Ask: "What number must we add to 2? What numeral replaces the placeholder? Add 6 to 2. What number do you get?"

Now refer again to the sentence ▥ − 6 = 2 that you have written on the chalkboard. Ask the children to give the numeral that replaces the screen. Then write the sentence 8 − 6 = 2 on the chalkboard. Have various children read this sentence.

Lead the children to discover that the number 8 answers the question asked in the problem. Have a child read the problem. Then have another child give the answer to the question asked. [Jane had 8 dimes before she used 6 of them to buy a horn.]

Work with the story problems in pictures B, C, and D in a similar way. For problems C and D, have the children give orally the sentences that tell what is to be done to find the replacement for the placeholder (for C, "Add 1 to 5"; for D, "Add 3 to 4"). Then have them build these sentences at their desks. Also, have them use their cards to build the sentences "6 − 1 = 5" and "7 − 3 = 4."

STA 2 page 133
Problem solving: subtractive action -- sentences of the form ▥ − 4 = 2

The children continue to analyze verbal problems expressed by sentences of the form ▥ − 4 = 2.

Adapt the teaching procedures given for page 132 to this page. Have the children read each problem and interpret the problem with the help of the accompanying picture. Then have them write or build with cards the mathematical sentence that "fits" the problem. This sentence should contain a placeholder.

Next, have the children give the sentence that tells what computation should be performed ("Add 2 to 5" for the first problem). Then have them write or build the sentence again, this time with the numeral that replaces the placeholder. Finally, ask the children to answer the question asked in the problem.

Practice tablet page 114
Workbook edition page 210

Say: "Read each problem carefully and study the picture that is beside it. Next, on the

first response space, write the sentence that describes the problem. Be sure to leave a space to hold the place for the number you are to find. Then, on the second response space, write the sentence with the number that replaces the screen."

STA 1 page 124

Keeping skillful: problems expressed by sentences of the form ■ − 4 = 2, 3 + 2 = ■, *and* 6 − 4 = ■; *addition and subtraction basic facts*

The children apply the methods they have been studying to find the solutions of problems that involve either additive action or subtractive action. The problems on this page are expressed by sentences of the forms ■ − 4 = 2, 3 + 2 = ■, and 6 − 4 = ■.

If possible, have the children complete the work for the verbal problems independently. As a preliminary activity, you may wish to go through the problems orally with the children. Have them read each problem, write the letter that identifies it on their papers, and for each problem write the following: a sentence that expresses the problem situation (for problem A, ■ − 8 = 6); a sentence that tells what computation is performed ("Add 2 to 4" for A); a sentence that expresses the problem situation with a numeral instead of a placeholder (6 − 2 = 4 for A); and a sentence that answers the question asked in the problem ("4 girls were playing tennis to begin with").

Have the children who cannot complete the work independently use markers to illustrate the action in each problem.

Use the two blocks of exercises at the right (red letters A through E; green letters A through E) to reinforce the children's learning of basic facts. Also have the children recite the sentences in the first block of exercises in the verbal problems on this page to strengthen their understanding of problem-solving procedures (sentence F relates to problem A). These two blocks of exercises may be discussed orally, or they may be assigned as written work.

Practice tablet page 125

Workbook edition page 211

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem, and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the number that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work or after they have completed Problems A through F, direct attention to exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

STA 2 page 126

Keeping skillful: problems expressed by sentences of the forms 3 + 2 = ■, 6 − 4 = ■, ■ + 2 = 5, *and* ■ − 4 = 2; *addition and subtraction basic facts*

The children again apply their knowledge of problem solving to finding the solutions of problems. This time they are required to differentiate among the four types of problems they have studied so far. The children also study again some of the addition and subtraction basic facts they have studied up to this point.

The suggestions given for teaching page 124 may be adapted for use with page 126. Call attention to the fact that the problems presented on this page require four different kinds of sentences. Encourage independent work. Permit the children to use markers to help them illustrate the action described in the problems.

The exercises at the right of page 135 will help you to evaluate how well the children know these basic facts. You can also have the children relate the sentences in the first block to the verbal problems on this page.

STA 2 page 136

Keeping skillful: problems expressed by sentences of the forms $3 + 2 = \square$, $6 - 4 = \square$, $\square + 2 = 5$, *and* $\square - 4 = 2$; *addition and subtraction basic facts*

The children again solve problems that require them to differentiate among four different problem types. They work with addition and subtraction basic facts given in the form "Add 1 to 2" or the form "Subtract 6 from 7."

The suggestions given for teaching pages 134 and 135 may be adapted for use with this page. Encourage the children to work independently.

Practice tablet page 116

Workbook edition page 212

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the number that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

Practice tablet page 117

Workbook edition page 213

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem, and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the number that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "Read Exercise A. Subtract 1 from 8. What numeral should you write on the response space. [7] Write 7 on the response space. Complete each of the other exercises."

Practice tablet page 118

Workbook edition page 214

Direct attention to Exercise A. Have the children read Exercise A silently. Then say: "Where are you to begin? [At D] Put your finger on D. In which row are you to write the letter S? [Row 4] In which direction are you to count? [From bottom to top] Find Row 4. In which box are you to write the letter V? [Box 3] In which direction are you to count? [From right to left] Find the third box in Row 4. Trace the letter S.

"For each of the other exercises, read the directions given. Then write the letter named in the correct box."

FUNDAMENTAL OPERATIONS

In this "Fundamental operations" section, the children learn about the associative property of addition, multiplicative action, and divisive action.

The children have studied one property of addition — the commutative property. They learned that in addition, the order in which the addends are taken does not affect the sum. Thus, $4 + 5 = 5 + 4$. Now they study another property of addition — the *associative property*.

The operation of addition is a binary operation, that is, an operation that involves only two numbers. This means that it is possible to add only two numbers at a time. If there are more than two addends, as in $4 + 2 + 3$, a decision must be made as to the order in which the addends are to be paired. In $4 + 2 + 3$, it is possible to pair 4 and 2 first. The sum $4 + 2$, or 6, is then added to 3, and the result is 9. It is also possible to pair 2 and 3 first. The sum $2 + 3$, or 5, is then added to 4, and the result is 9. The associative property of addition assures that the sum of "4 + 2" and "3" is the same as the sum of "4" and "2 + 3." In other words, the order in which the numbers are paired does not affect the sum.

The children have studied joining situations in which one set of objects joins another set. They learned that the word "plus" and the symbol "+" are associated with these joining situations. The children also studied separating actions in which some members of a set are removed from a set. They learned that the word "minus" and the symbol "−" are associated with action situations of this type. Now the children study a new situation involving joining action (multiplicative action) and a new situation involving separating action (divisive action).

Suppose that 3 sets of kittens are coming together at the same time and that there are 2 kittens in *each* set. Note that the sets are equivalent sets. Remember that, if sets are equivalent, the same number, in this case the number 2, is associated with each set. A multiplicative situation arises when equivalent sets join, and the joining action is thought of as simultaneous and not as successive. The situation in which the 3 sets of 2 kittens each come together at the same time is an example of multiplicative action. Action situations of this type lead to the operation of multiplication.

Now suppose that a set of 6 ducks are separating into equivalent subsets and that there are 2 ducks in *each* subset. A divisive situation arises when a set separates into equivalent subsets, and the separating action is thought of as simultaneous and not successive. Separating actions of this type lead to the concept called division.

Through the use of pictures, the children learn to identify multiplicative actions and divisive actions. They learn that any one of the following phrases may be used to name a number in terms of the multiplicative action involved: "3 twos," "3 times 2," "3 × 2," or "2 multiplied by 3." They also learn that the phrase "6 divided by 2" or the phrase "6 ÷ 2" names a number in terms of the divisive action involved. Such phrases as $6 \div 2$ name the number of equivalent subsets.

In this "Fundamental Operations" section, no attention is given to finding the *standard name* for numbers named by such phrases as "4 times 2," "3 multiplied by 3," and "8 divided by 4." Finding the standard name for numbers expressed by such phrases is dealt with in the section on multiplication and division basic facts. At this time, the children should be concerned only with recognizing and symbolizing multiplicative situations and divisive situations.

STA 2 page 197
Workbook edition page 215
The associative property of addition

The children learn that when they are to add three numbers they first must decide in which order the numbers are to be paired. They also learn that the order in which the numbers are paired does not affect the sum.

The obviousness of some mathematical properties tends to hide their importance. One such property is the *associative property of addition*. This property assures that the sum of "4 + 2" and "3" is the same as the sum of "4" and "2 + 3." The term "property" is used because the idea involved is characteristic of any three natural numbers.

It is not necessary that the children learn the term "associative property of addition." All that is needed at this time is that they have an understanding of the basic idea involved as preparation for future work in addition.

Refer to picture A and proceed to ask questions and make statements similar to those that follow: "How many chickens are there in each group? We are going to find how many chickens there are in all. We will use two ways to do this."

Direct attention to picture B. Ask: "Are the same sets of chickens shown in picture B as in picture A? Which set is dimmed? Which sets are not dimmed? Which sets of chickens are we to think of in this picture? What is happening to these two groups of chickens? What word can we use to describe one set joining another set? [Plus] What phrase names the number of chickens in the set after the 3 chickens have joined the 2 chickens? [2 + 3]

"Look at the phrase shown below the chickens. Notice the curved marks around 2 + 3. These marks are called 'parentheses.' Read the phrase in parentheses. [Two plus three] The parentheses show that we first add 2 and 3. What is another name for the number named by 2 + 3? [Five] Notice the numeral '5' below the phrase in parentheses.

"Now look at Picture C. What is happening in this picture? How was this set of five chickens obtained? Look at the phrase shown in Picture C. Does this phrase tell what is happening? How do we read this phrase? [Four plus five]

"Now look at picture D. All the chickens are in a single set. How many chickens are in the set? [Nine] Is the numeral '9' the standard name for the entire set? [Yes]

For Pictures E, F, and G, adapt the procedures suggested for Pictures B, C, and D. Be sure the children understand that the same chickens are shown in each picture on the page. As you discuss picture E, get the children to use the word "parentheses" and to explain how the symbols for parentheses are used on this page.

Direct attention to Picture H. Relate the first scene in this picture to Picture D and the second scene in this picture to Picture G. Then say: "Read the first mathematical sentence in Picture H. What is another name for 'four plus five' in the first scene of picture H? What is another name for the phrase 'six plus three' in the second scene? Why can we use 'is equal to' in the first sentence shown in picture H? [Because 4 + 5 and 6 + 3 are names for the same number, nine.]"

Write on the chalkboard the sentence "4 + 2 + 3 = 4 + 2 + 3." Draw a line below the phrase at the left of the symbol "=." Ask the children to read the sentence. Then say: "I have drawn a line under one part of the sentence. Look at that part. It tells us that we are to add 4, 2, and 3. First we must add two of the numbers. Look at the picture of the chickens in the first scene of picture H. The ring shows that first we are to think of adding 2 and 3. In the phrase on the board, how can we show that we first want to add three to two? [By placing curved marks called parentheses around the '2 + 3']" Draw the parentheses. Emphasize again that the parentheses show that the 3 is to be added to the 2 first. Ask: "Then what do we do? [Add 5 to 4] What number do we get?"

In a similar way discuss the phrase written on the chalkboard at the right of the symbol "=" and relate it to the second scene of picture H. Then direct attention to the second

sentence in picture B. Ask: "How can you tell which numbers we should add first in the scene at the left? How can you tell which numbers we should add first in the scene at the right? What is another name for the phrase at the left? What is another name for the phrase at the right? Why can we use '=' to mean 'is equal to' in the sentences' (Because $4 + (3 + 8) = (4 + 3) + 8$ mean the same number, right?"

Provide the children with sets of markers, each set of markers being in a different color. Give them practice in counting; for example, they might combine a piece of red paper, 3 pieces of green paper, and three pieces of blue paper. Also, give them experiences in combining other sets (say, sets of 2, 1, and 3 objects). Then have them write sentences similar to those on page 187 (Wkbk, page 215) using parentheses to show how they paired the numbers. Have them give the sum for the numbers expressed in each phrase. Encourage them to use the word "parentheses."

STA 2 page 188

Workbook edition page 216

The associative property of addition

The children continue to study the associative property of addition.

Adapt the teaching suggestions given for page 187 (Wkbk, page 215) for this page. For each picture, except picture 3, the children are to name the replacements for placeholders. For example, in picture B, the phrase $8 + 4$ replaces the wavy line, and the numeral 7 replaces the square screen. In picture 3, the phrase $4 + 1$ replaces the wavy line, and the numeral 5 replaces the round screen.

After you have finished the work in the Wkbk, be sure the children can state the generalization that when three numbers are to be added, the numbers can be paired and added in any convenient way.

STA 2 page 189

Workbook edition page 217

Associative property of addition; practice on the commutative property, on the ideas of "greater than" and "less than," and on betweenness for numbers

The children apply their knowledge of the associative property in independent practice. They also review the commutative property for addition of natural numbers, the ideas of "greater than" and "less than," and betweenness for numbers.

Exercises 1 and 2 may be used for class discussion. For exercise 1, get the children to explain how $(3 + 1) + 5 = 3 + (1 + 5)$, in the second step, was obtained from $2 + 1 + 5$ and how $3 + (1 + 5) = 3 + 6$ in the third step was obtained. Then get them to make the generalization that explains the 5 in the fourth step. Use the same procedure for exercise 2.

Exercises C through F (red letters) may be used for independent work. This work should be written, since the children have not been taught to read $(1 + 2) + 3$, for example, as "The phrase 1 plus 2 added to 3." The children have a pattern for their work in exercises A and B, but encourage them to work without using these exercises if they can.

The rest of the page should be used for independent work. Notice that the blue-lettered exercises A through E review the commutative property for addition of natural numbers. This work may prompt some of the older pupils to ask if there are ways of pairing when adding 4, 2, and 3, for example, other than the ways shown in exercise A. Tell them that there are many ways (there are twelve ways if we use both the commutative and the associative properties). And suggest that they try to find all of these ways. The twelve ways of pairing these three numbers for adding are shown at the top of the next page.

1 + 2 + 3

(1 + 2) + 3	(3 + 1) + 2	(2 + 3) + 1
1 + (2 + 3)	3 + (1 + 2)	2 + (3 + 1)
1 + (3 + 2)	3 + (2 + 1)	2 + (1 + 3)
(1 + 3) + 2	(3 + 2) + 1	(2 + 1) + 3

The last block of exercises on this page, may be used for either oral or written work. Observe that many responses are possible for each of the exercises from P through V. For these exercises, encourage abler pupils to give explicit, detailed responses. As an example, for exercise P, they might say: "Fifteen is greater than any number from zero through fourteen."

Practice tablet page 119
Workbook edition page 218

Explain to the children that Exercises A through J are like the exercises on page 139 (Wkbk, page 217). Tell them to complete Exercise A. Check to see that the children understand how to complete the exercise. One way in which Exercise A can be completed is:

$$2 + 2 + 4$$
$$(2 + 2) + 4 = 2 + (2 + 4)$$
$$4 + 4 = 2 + 6$$
$$8$$

Another way is:

$$2 + 2 + 4$$
$$2 + (2 + 4) = (2 + 2) + 4$$
$$2 + 6 = 4 + 4$$

If the children have difficulty with this exercise, work Exercise A on the chalkboard. Then have the children complete the other exercises.

Either before the children begin to work or after they have completed Exercises A through J, direct attention to Exercises A through V. Tell the children to complete each exercise by writing the correct numeral on the response space.

STA 2 page 140
Workbook edition page 219
Multiplicative action; divisive action

The children study the special kind of combining action that may be called multiplicative action and the special kind of separating action that may be called divisive action. They use, orally, certain phrases that describe such actions and name the resulting number.

Tell the children to look at all the pictures on the page and to notice that two kinds of action are shown in these pictures. Then ask if anyone has discovered what these two kinds of action are. The children should say that some pictures (A, D, and F) show sets that are coming together, and that the other pictures (B, C, and E) show sets that are separating.

Tell the children to examine the second scene in each picture. Ask if anyone has noticed anything special about the sets. Ask questions to help the children discover that each subset contains the same number of objects and that the objects are moving.

Direct attention to picture A, and formulate statements and questions similar to the following: "Look at the first scene of the picture. How many sets of kittens are there? How many kittens are in each set? Now look at the second scene. Is the number of sets the same as in the first scene? Is the number of kittens in each set shown in the second scene the same? What is happening? Are the sets coming together, or are they separating? Are all the sets moving? When sets that have the same number of objects come together, we can talk about the action in a special way. How many sets are coming together? How many objects are in each set? Three sets of two objects each are coming together. Another way to tell what is happening is to say 'three twos.' We can also say 'three times two.' The word 'three' tells how many sets there are, the word 'times' tells us that the sets are coming together at the same time, and the word 'two'

tells us what there are two objects in each of the three sets. Each of these sets is telling what is happening when those sets of two objects each are coming together."

Have the children find another picture that shows set combining. Suppose they select picture F. Proceed somewhat as follows: "Look at the first scene. How many sets are there? How many lambs are in each set? Look at the second scene. Are there just as many sets here as in the first scene? Is the number of lambs in each set the same as in the first scene? What is happening? (Two sets of three lambs each are coming together.) Why should we say 'two threes' instead of 'three twos' to tell what is happening? What is another way to say this? (Two times three.)"

Have the children find the third picture on the page (picture D) that shows multiplicative action and go through the procedure again. Then, in succession, have the children use their markers to build three sets of two, four sets of two, and two sets of three, and for each of these situations show the multiplicative action. To do this, have them use both hands to push the sets together simultaneously to make one set. Each time the children perform the combining action, have them give two phrases for the action. Do *not* ask for the number of the final set at this time.

Refer to picture E and proceed somewhat in this way: "Now we are going to work with the pictures that show separating action. How is the first scene of picture E different from the first scene of picture A? (It shows only one set, instead of three.) How many ducks are in this set? Look at the second scene. What is happening? How many ducks are there in each set?

"We can think about the action in E in a special way also. How many objects are in the set in the first scene? How many objects are in each set in the second scene? For picture E, we can say 'six divided by two.' This means that a set of six objects has been separated into sets of two objects each." As this time, avoid asking for the number of equal sets shown in the second scene of picture E (3).

Have the children find another picture that shows divisive action. Suppose they choose picture F. Make statements and ask questions similar to these: "How many frogs are in the set shown in the first scene? What is happening in the second scene? (The 8 frogs are separating.) How many frogs are there in each set? What can we say to show what is happening? (Eight divided by four)" As for picture E, avoid emphasis on the number of equal groups named by the phrase.

Have the children find the third picture that shows divisive action and go through the procedure again. Be sure to have the children give the phrase that is appropriate to the action. Keep the emphasis only on the number of objects in each set and on the fact that the number of objects is the same in each subset associated with the separating action. Do *not* ask how many sets there are.

Since it is difficult to show divisive action with markers when the number of sets is greater than two, it might be best to let the children dramatize this action. Have the children form in a group of six and then separate into groups of two; then form in a group of nine and separate into groups of three; then a group of eight again and separate into groups of four. This reproduces the divisive action shown in pictures E, C, and B. Each time the children separate into groups, have them give orally the phrase for the divisive action.

As a final activity, you can take each picture on this page in any order and have the children give the phrase that names the number of objects in terms of the action involved. This will give them an opportunity to differentiate between multiplicative and divisive action as shown in pictures.

STA 2 page 141
Workbook edition page 220

Multiplicative action; divisive action

The children distinguish between multiplicative action and divisive action. They formulate appropriate phrases for these actions, and they use the words "multiplied by" in a new phrase for multiplicative action.

With a group of abler pupils, it should be possible to take the pictures in order. The children should determine if the action shown in each picture is that of combining equivalent sets or that of separating a set into equivalent subsets. Then, for each picture, they should give the phrase (or phrases) appropriate to the action.

If you use this approach, introduce the phrase "3 multiplied by 3" when you reach picture C. Develop the use of "multiplied by" with great care, in the way suggested in the notes for this page, because a problem arises in certain situations. In picture E, for example, the children should say "4 multiplied by 2." Note, however, that the numerals in this phrase are reversed as compared to the order of the numerals in the phrases they have been using. In this case, these phrases are "2 fours" and "2 times 4." However, if the children clearly understand that 2 is the number of sets and that 4 is the *number of objects in each set,* they will quickly accept the new phrase "4 multiplied by 2."

Be sure the children understand that in a picture that shows divisive action, the number of the set that is being separated into subsets must be determined before they can build the phrase for the action. If necessary, let them use their markers and, for picture A, for example, show the four sets of 2. Then they should push the sets together and decide that 8 is the number of the set before it was separated into subsets.

With slower children, adapt the suggestions given in the notes for page 140 (Wkbk, page 219). Work first with the pictures that show multiplicative action and develop the new phrase that includes the words "multiplied by." Then work with the pictures that show divisive action. For each of these pictures, let the children use their markers to determine the number of the original set.

As a final activity for all the children, work with the pictures in any order, but alternate between the two types of action. For each picture that shows multiplicative action, have the children give the three phrases that name the number of objects in terms of the action involved. (For example, for picture G, they should say "four twos," "four times two," and "two multiplied by four.") For each picture that shows divisive action, have the children give the phrase that names the number of objects in terms of the action involved.

You could also, if you wish, give various phrases and ask the children to give the letter of the picture that "fits" the phrase. For example, you could say "nine divided by three," for which the children would respond by selecting picture I.

STA 2 page 142
Workbook edition page 221

Multiplicative action; introduction of printed words "times" and "multiplied by" and symbol "×"

The children work with pictures that show multiplicative action. They learn to recognize and read the phrases associated with the action. They also learn to recognize the symbol × for multiplication.

Direct attention to the first scene of picture A. Tell the children that the sets of objects are covered so that we cannot tell how many objects are in each set. Ask how many sets there are and if the printed numeral tells how many sets there are.

For the next scene, tell the children that now we can see the objects in each set. Ask again how many sets there are. Then ask how many tigers are in each set; if the number of

tigers in the same in all the sets; and if the printed numeral tells how many tigers are in each set.

Proceed to the third scene. Get the children to describe what is happening and give orally the three phrases that name the number of tigers in terms of the action involved. Introduce the new words and have the children read each phrase. Then point out the symbol for multiplication. Explain that this symbol is read as "times," and that "4 times 2" and "4 × 2" are read in exactly the same way. Have a child read the phrase "8 × 2."

Be sure the children understand that, in 2 × 4, the numeral 4 tells how many sets there are; the symbol "×" tells that the sets are counted together at the same time; and the numeral 2 tells how many tigers are in each set.

Work with pictures B, C, and D in a similar way. In pictures B and D the children are required to supply words or numerals to complete a phrase. Be sure the children can readily distinguish the numeral that tells how many objects are in the set. Give special attention to the phrase that includes the words "multiplied by," since this phrase is still new to the children.

When work with the pictures has been completed, have the children write, for each picture, the phrase for the action. Tell them to use the "times" symbol.

Practice tablet page 130

Workbook edition page 222

Direct attention to Picture A. Say: "Give the name for the number of legs that tells what is happening. (Be sure the children give *four times three* as the response.) What numeral should you write on the response space before the word *times*? (4) Write 4 on this response space. What numeral should you write in the response space after the word *times*? (3) Write 3 on this response space. Now write 4 *times* 3 on the long response space. Use the symbol for times."

Tell the children to work with each of the other pictures in the same way.

SRA 2 page 149

Workbook edition page 223

Division action; introduction of printed words "divided by" and symbol ÷

The children work with pictures that show divisive action. They learn to recognize and read the phrase that names the number of objects in terms of the action involved. They also learn to recognize and use the symbol "÷."

Direct attention to the first scene of picture A. Ask how many rabbits are shown in this scene. Ask if the printed numeral tells how many rabbits are in the set.

Proceed to the second scene. Say: "How many rabbits are in this set? Does the printed numeral '2' tell how many rabbits are in the set? The numeral '2' tells us that the set of 8 rabbits in the first scene is going to separate into sets of 2."

For the third scene, ask questions similar to the following: "What is happening? How many rabbits are there in all? How many rabbits are in each set? Are there 2 rabbits in each set? Are all the sets moving? What phrase tells us that a set of eight is separating into sets of two?"

Introduce the new words and have the phrase "eight divided by two" read aloud. Identify the symbol for division and explain that "8 ÷ 2" is read in exactly the same way as the phrase immediately above it. Be sure the children understand that, in 8 ÷ 2, the numeral 8 tells how many objects there are in all; that the symbol "÷" tells that the sets are separating; and that the numeral 2 tells how many objects are in each subset.

Work with pictures B, C, and D in much the same way. Where that of pictures C and D the children are required to supply numerals to replace the screens.

As a further activity, for each picture, have the children write the phrase that names

the number of objects in terms of the action. Tell them to use the symbol for "divided by."

Practice tablet page 121
Workbook edition page 224

Direct attention to Picture A. Say: "Give the name for the number of groups of dogs. This name should tell what is happening. [Be sure the children give *eight divided by four* as the response.] What numeral should you write on the response space before the words *divided by*? [8] Write 8 on this response space. What numeral should you write on the response space after the words *divided by*? [4] Write 4 on this response space. Now write 8 *divided by* 4 on the long response space. Use the symbol for *divided by*."

Tell the children to work with each of the other pictures in the same way.

STA 2 page 144
Workbook edition page 225
Distinction between multiplicative action and divisive action

The children distinguish between multiplicative action and divisive action. For each picture, they build the phrase that names the number of objects in terms of the action involved.

Let the children look over the page to determine that both combining action and separating action are shown. Then start with picture A and use the pictures in order.

Make statements and ask questions like the following: "What is happening in picture A? [The ducks are coming together.] How many sets of ducks are there? Is each set of ducks moving? How many ducks are in each set? Look at the two numerals and the wavy line below the picture of the ducks. Which words, 'divided by' or 'multiplied by,' should replace the wavy line? Find the correct *words* at the top of the page. In the phrase 'three multiplied by three,' what does the first numeral 3 tell you? [How many ducks are in each set] What does the second numeral 3 tell you? [How many sets of ducks there are]"

Then say: "Which symbol should you use to replace the wavy line? [For Picture A, either 'The symbol for times' or 'The symbol with the green mark (Wkbk, brown mark) under it'] Read the phrase with the symbol that replaces the wavy line. [Three times three] Now what does the first numeral 3 tell you? [How many sets of ducks there are] What does the second numeral 3 tell you? [How many ducks are in each set] Write the letter A on your paper. Then, alongside the letter, write the phrase for the action shown in the picture. Use the symbol for 'times.'" (If you wish, you can defer this writing activity until all the work with the pictures has been completed.)

Proceed in much the same way with each of the other pictures, making suitable adaptations for those pictures that show divisive action. (If the children have difficulty in indicating the correct words and symbols, have them respond by giving the color of the mark under the words and symbols.

Pay special attention to pictures F and G. For these pictures, the numeral that replaces the square screen (or the round screen) will be different when the words "multiplied by" are used than when the symbol "×" is used; that is, the correct responses for picture F are "3 multiplied by 2" or "2 × 3."

Practice tablet page 122
Workbook edition page 226

Direct attention to Picture A. Say: "Does this picture show a joining action or a separating action? [A separating action] Which should you use, the word *times* or the words *divided by*? [Divided by] Draw a ring around the words *divided by*. What is the name for the number of groups of horses that tells what is happening? [Be sure the children give *nine divided by* three as the response.] Write 9 ÷ 3 on the response space. Use the symbol for *divided by*.

work has been completed, have the children write the appropriate phrase for each picture.

Practice tablet page 124
Workbook edition page 228

Say: "For each of the pictures, decide if the action in the picture is a joining action or a separating action. Draw a ring around the word or words you should use for this action. On the response space, write the name for the number of objects shown. This name should tell what is happening."

Practice tablet page 125
Workbook edition page 229

Say: "For each of the pictures, decide if the action in the picture is a joining action or a separating action. Draw a ring around the word or words you should use for this action. On the response space, write the name for the number of objects shown. This name should tell what is happening."

Practice tablet page 126
Workbook edition page 230

Say: "Read Exercise A. Use the picture to find your response. Write your responses on the response spaces. To each of the other exercises in the same way. For some exercises, you will not use all of the response spaces."

BASIC FACTS

The children are now ready to take another significant step toward achieving basic objectives in the study of mathematics. As has been stated, the solution of a quantitative problem requires the following: an analysis of the situation involved; an expression of this analysis in mathematical symbolism; and the computation that is necessary to find the standard symbol for the number that answers the question asked in the problem. To be successful in problem solving, the children must understand the meaning of addition, sub-

traction, multiplication, and division. They must also know the basic facts for each of these operations.

Thus far, the children have studied the addition and subtraction basic facts with sums and minuends of 2 through 12. Now they are ready to study the multiplication and division basic facts with products and dividends of 4, 6, 8, 9, 10, and 12.

The children have learned that a multiplicative situation arises when equivalent sets combine and the combining action is thought of as simultaneous. They also learned that a divisive situation arises when equivalent sets separate and the separating is thought of as simultaneous.

The children have built such phrases as "3 times 2," "4 multiplied by 2," "2 × 3," "8 divided by 2," and "4 × 3." They know that each of these phrases names a number in terms of the action involved. Now they learn the standard names for numbers expressed by such phrases. (Remember that a standard name for a number is any of the numerals 0, 1, 2, 3, and so forth.) For example, 12 is the standard name for the number named by 4 × 3; 4 is the standard name for the number named by 8 ÷ 2. When the children learn the standard names for numbers named by phrases, they are focusing their attention on name changing and are processing the numerals.

In the multiplication basic fact 4 × 3 = 12, 4 is the *multiplier*, 3 is the *multiplicand*, and 12 is the *product*. In the division basic fact 8 ÷ 2 = 4, 8 is the *dividend*, 2 is the *divisor*, and 4 is the *quotient*. It is not necessary to use the terms product, divisor, and so on, in talking with the children, because at the elementary level, they should learn the ideas involved without being burdened with the task of learning the terms.

To facilitate learning, the multiplication and division basic facts are organized in terms of products and dividends. Furthermore, the facts are organized in such a way that the relationship between multiplication and division is emphasized. Multiplication is considered a "doing" operation, and division an "undoing" operation. Consider 4 × 2 = 8 and 8 ÷ 2 = 4. In the "doing" operation (4 × 2 = 8), 4 sets of 2 objects each are combining. In the related "undoing" operation (8 ÷ 2 = 4), a set of 8 objects is separated into sets of 2. Although this relationship is inherent in the presentation of the basic facts for each number, attention is not focused directly on the relationship until after the basic facts through 12 have been presented.

The basic facts with products and dividends through 12 are presented on pages 146 through 161 of *STA 2* (Wkbk, pages 231 through 244). Thus, 24 basic facts are introduced in this order: the facts for 6, for 8, for 10, for 4 and 9, and for 12. The basic facts for 4 and 9 are not presented until after the facts for 6, 8, and 10 because, in each case, the number of objects in each subset and the number of equal subsets is the same (2 subsets of two, and 3 subsets of three). By learning the facts with products and dividends of 6, 8, and 10, the children become familiar with expressing the basic facts in more general cases and can then handle the facts with products and dividends of 4 and of 9 readily. The set of 12 is significant because the children must group the original set, or resulting set, as a set of 10 and a set of 2 to recognize the number associated with the set.

STA 2 page 146
Workbook edition page 231
Basic facts: products of 6

The children have learned that a phrase names a number in terms of the action involved. Now they learn that the numeral 6 is the standard name for the number named by 3 × 2 and 2 × 3.

Pictures A and B, which should be used to introduce the multiplication basic facts for 6, consist of two scenes. The first scene of

each picture shows the action, and the second scene shows the set resulting from the action. Pictures C through F, which should be used to reinforce the children's learning of the multiplication basic facts for 5, show only the action that is taking place.

Have the children look at this page as a whole. They should discover that each picture shows a situation in which the action is a combining action. Then say: "Look at the first scene in picture A. How many sets of chickens are there? Is the number in each set the same? How many chickens are in each set? Are all the sets of chickens moving? Is the action a separating or a combining action? What word or words can we use to describe it? [times, multiplied by] The phrase 'three twos' tells how many chickens there are in all. What other phrases tell how many chickens there are in all? [3 times 2; 2 multiplied by 3] Now we want to find the standard name for the number we have been talking about.

"Look at the second scene in picture A. What does this scene show? How many chickens are in this set? Is the number of chickens shown in both scenes of picture A the same? Is 6 the standard name for 3 times 2?"

Have various children read aloud the sentence given in picture A. On the chalkboard, write the following three sentences: 3 twos = b; 3 × 2 = c; 3 multiplied by 2 = d. Have various children read each sentence aloud. Be sure the children understand that b is the standard name for the number named by each answer and that each sentence "fits" the situation pictured in A.

Provide classroom opportunities for the children to dramatize situations that represent 3 × 2 = 6. Since it is difficult to show multiplicative and divisive action with sets of objects,

Use a similar teaching procedure for picture B.

Call attention to picture C. Say: "How many sets of pigs are there? Is the number of pigs in each set the same? How many pigs are in each set? Are both sets of pigs moving? What is happening? What word or words can we use to describe the action? Does the phrase '2 threes' tell how many pigs there are in all? What other phrases tell the number of pigs in all? [2 multiplied by 3; 2 times 3] What is the standard name for the number of pigs? [6]"

Direct attention to the sentence 2 × 3 = ■. Have the children read the sentence and decide what numeral replaces the placeholder. The completed sentence (the sentence that contains the numeral that replaces the screen) may be given orally, or it may be written.

Adapt a similar procedure for pictures D, E, and F. Provide opportunities for the children to dramatize situations that express 3 × 5 = 15.

STA 2 page 147

Workbook edition page 89

Basic facts: dividends of 6

The children study the division basic facts for 6. They learn the standard name for 6 ÷ 3 and for 6 ÷ 2.

Pictures A and B, which should be used to introduce the division basic facts for 6, consist of two scenes. The first scene of each picture shows the original set of objects, and the second scene shows the action that is taking place. Pictures C through F, which should be used to reinforce the children's learning of the division basic facts for 6, show only the action. For these pictures the children must determine the numerousness of the original set before they can give the sentence that "fits" the situation.

In a divisive situation, the result is the number of equal subsets obtained (quotient). Hence, in discussing divisive situations, such as that shown in the second scene of picture A, do not ask the children how many equal subsets there are until after they have built the phrase 6 ÷ 3 = ■. Only then should attention be focused on the number of equal subsets.

Let the children look at the page as a whole. They should observe that each picture shows a

situation in which the action is a separating action. Say: "Look at the first scene in picture A. How many clowns are there? Now look at the second scene. The same clowns are shown in this scene. Is the action in the second scene a combining action or a separating action? Is the number of clowns in each set the same? How many clowns are in each set? Are all the sets of clowns moving? What word or words do we use to describe this separating action? What phrase tells how many sets of clowns there are? Is 6 ÷ 2 a name for a number? 6 ÷ 2 is one name for the number that tells how many sets of clowns there are. Now we want to find the standard name for the number named by 6 ÷ 2.

"Look again at the second scene in picture A. How many sets of 2 clowns are there? Are '6 ÷ 2' and '3' names for the same number? What is the standard name for the number named by 6 ÷ 2?"

Call attention to the sentence given in picture A. Have various children read the sentence aloud. Be sure that the children understand that 3 is the standard name for the number named by 6 ÷ 2 and that both '6 ÷ 2' and '3' tell how many equal subsets there are.

Provide opportunities for the children to dramatize situations that represent 6 ÷ 2 = 3.

Use a similar teaching procedure for picture B.

Call attention to picture C. Use questions similar to the following: "Is the action a combining action or a separating action? How many airplanes were in the set before the airplanes separated? Is the number of airplanes in each set the same? How many airplanes are in each set? Are both sets of airplanes moving? What word or words can we use to tell what is happening? What phrase tells how many sets of airplanes there are? How many sets of 3 airplanes are there? What is the standard name for 6 ÷ 3?"

Finally, have the children read the sentence in picture C silently. Then have them decide what numeral replaces the placeholder. The completed sentence may be given orally, or it may be written.

Adapt a similar procedure for pictures D, E, and F. Provide opportunities for the children to dramatize situations that express 6 ÷ 2 = 3 and 6 ÷ 3 = 2.

STA 2 page 148

Basic facts: products and dividends of 6; sums and minuends through 6

The children apply what they have learned about the basic facts with products and dividends of 6. They also reinforce their learning of the basic facts with sums and minuends of 2 through 6.

The pictures on this page show all the types of action that the children have studied — additive, subtractive, multiplicative, and divisive. For those pictures that illustrate a combining action, the children must decide whether one set is joining another set (additive action) or whether the sets can be thought of as combining simultaneously (multiplicative action). For those pictures in which the action is a separating action, the children must decide whether some members of the set are moving away from the rest of the set (subtractive action) or whether the set can be thought of as separating simultaneously (divisive action).

Note that in picture H, a situation involving unlike objects is illustrated. The kind or kinds of objects is not important in an action situation. It is the number associated with each of the sets that is important.

Some children may be able to do the work on this page independently. For pictures A through H, tell these children to study each picture carefully and to decide what sentence expresses the situation pictured. Then instruct them to write on their papers the letter that labels a picture and the mathematical sentence that expresses the situation shown.

for picture A, they would write the sentence $3 \times 2 = 6$.

For exercises A through D, have the children decide what numeral replaces the placeholder and write the completed mathematical sentence on their papers. For exercise A, they should write the sentence $8 - 6 = 2$.

The other children in the class should participate in activities similar to the following. Call attention to picture A. Say: "Is the action a separating action or a combining action? How many sets of dolls are there? Is the number of dolls in each set the same? How many dolls are in each set? What word or words do we use to describe this combining action? ['Times' or 'multiplied by'] What phrase tells how many dolls there are in all? [Accept any of the following: 3 twos; 3×2; 3 multiplied by 2.] What is the standard name for the number named by 3×2? Jim, give a sentence that tells what is happening in picture A. [$3 \times 2 = 6$]"

Follow a similar procedure for each of the other pictures. Provide opportunities for the children to dramatize each situation represented by a picture.

After all the pictures have been discussed, direct attention to the exercises at the left. Have the children read an exercise silently and decide what numeral replaces the placeholder. Then have a child read the sentence aloud, supplying the correct numeral.

As another activity for page 148, have the children find a picture that shows the action situation suggested by a particular sentence in an exercise. (For example, picture C shows the action suggested by exercise d.)

If more practice seems necessary, select pictures at random. For each picture, have the children find the sentence at the left that relates to the situation. As an example, for picture B, the children could give sentence A or sentence C. Be sure the children understand that the sentence $8 - 2 = 4$ expresses a physical situation that is different from the situation expressed by $8 \times 2 = 6$.

Practice tablet page 127
Workbook edition page 283

Call attention to Picture A. Say: "What is the arithmetic sentence that tells what is happening in this picture? [$8 - 2 = 6$] On the response space, write $8 - 2 = 6$. For each of the other pictures, write on the response space the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through D. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 128
Workbook edition page 284

Say: "For each picture, write on the response space the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through V. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 149
Workbook edition page 285
Basic facts: products and dividends of 8

The children study the multiplication and division basic facts for 8. They learn that the numeral 8 is the standard name for the number named by 4×2 and by 2×4. They also learn the standard name for the number named by $8 \div 4$ and by $8 \div 2$.

Each picture on this page consists of two scenes. For those pictures that illustrate multiplicative action, the first scene shows the action, and the second scene shows the set that results from the action. For those pictures that illustrate divisive action, the first scene shows the original set and the second scene shows the action.

Have the children look at the page as a whole. They should discover that some pictures show multiplicative action and some pictures show divisive action. Then say: "Look at the first scene in picture A. How many sets of frogs are there? Is the number of frogs in each set the same? How many frogs are in each set? Are all the sets of frogs moving? Is the action a separating action or a combining action? What word or words can we use to describe the action? [Times, multiplied by] The phrase '4 twos' tells how many frogs there are in all. What other phrases tell how many frogs there are in all? [4 times 2; 2 multiplied by 4] Now we want to find the standard name for the number of frogs.

"Look at the second scene. What does this scene show? How many frogs are in this set? Is the same number of frogs shown in both scenes of picture A? Is 8 the standard name for 4×2?"

Have various children read aloud the sentence given in picture A. On the chalkboard, write the following three sentences: 4 twos = 8; $4 \times 2 = 8$; 2 multiplied by 4 = 8. Have the children read each sentence aloud. Be sure the children understand that 8 is the standard name for the number named by each phrase and that each sentence "fits" the situation pictured in A.

Use a similar teaching procedure for picture B.

After completing discussion of pictures A and B, direct attention to picture C. Say: "Look at the first scene in picture C. How many kittens are there? Now look at the second scene. The same kittens are shown in this scene. Is the action in the second scene a combining action or a separating action? Is the number of kittens in each set the same? How many kittens are in each set? Are all the sets of kittens moving? What word or words do we use to describe this separating action? What phrase tells how many sets of kittens there are? Is $8 \div 2$ a name for a number? $8 \div 2$ is one name for the number that tells how many sets of kittens there are. Now we want to find the standard name for the number named by $8 \div 2$.

"Look again at the second scene of picture C. How many sets of 2 kittens are there? Are '$8 \div 2$' and '4' names for the same number? What is the standard name for the number named by $8 \div 2$?"

Call attention to the sentence given in picture C. Have various children read the sentence aloud. Be sure the children understand that 4 is the standard name for the number named by $8 \div 2$ and that both "$8 \div 2$" and "4" tell how many equal subsets there are.

Adapt a similar teaching procedure for picture D.

For pictures E and F, have the children study the action scene, decide what phrase tells what is happening, give the completed sentence that expresses the situation, and finally tell what numeral replaces each of the placeholders in the sentence.

Provide opportunities for the children to dramatize situations that are expressed by $4 \times 2 = 8$, $2 \times 4 = 8$, $8 \div 2 = 4$, and $8 \div 4 = 2$.

STA 2 page 150

Basic facts: products and dividends of 8

The children have studied all the multiplication and division basic facts for 8. Now they apply what they have learned.

Direct attention to picture A. Say: "Is the action a combining action or a separating action? How many rabbits were there before they separated into sets? Are there the same number of rabbits in each set? How many rabbits are in each set? Are both sets of rabbits moving? What word or words can we use to describe the action? What phrase tells how many sets of rabbits are moving? How many sets of 4 rabbits are there? What is the standard name for $8 \div 4$?"

Direct attention to the sentence $8 \div 4 =$ ▨. Have the children read the sentence and decide what numeral replaces the placeholder. Then

have various children read the completed sentence.

Adapt a similar procedure for pictures D, E, and H, which also illustrate divisive situations.

After completing the discussion of picture A, call attention to picture B. Ask: "Is the action a separating action or a combining action? How many sets of clowns are there? Is the number of clowns in each set the same? How many clowns are in each set? Are both sets of clowns moving? What word or words can we use to describe the action? What phrases can we use to tell how many clowns there are in all? What is the standard name for the number named by '4 multiplied by 2'? What is the standard name for the number of clowns?"

Direct attention to the sentence $2 \times 4 = \blacksquare$. Have the children read the sentence and decide what numeral replaces the placeholder. Then have one child give the completed sentence.

Adapt a similar procedure for pictures C, F, and I, which show multiplicative situations.

Provide opportunities for the children to dramatize all the basic facts they have studied so far.

STA 2 page 151

Basic facts: products and dividends of 6 and 8; sums and minuends through 8

The children apply what they have learned about the basic facts with products and dividends of 6. They also reinforce their learning of the basic facts studied so far.

Both the pictures and the exercises include basic facts the children studied previously. Many of the children may be able to complete the work on this page independently.

For each picture, have the children first describe what is happening and then give a complete sentence that expresses the situation. For example, for picture B, they could give any one of the following sentences: 2 threes = 6; $3 \times 2 = 6$; 3 multiplied by 2 = 6.

After discussing all the pictures, direct attention to the exercises at the right. Have the children first decide what numeral replaces the placeholder and then give the completed sentence. The completed sentence may be given orally, or it may be written.

The teaching suggestions given for page 148 may be adapted for this page.

Practice tablet page 129

Workbook edition page 286

Call attention to Picture A. Say: "What is the arithmetic sentence that tells what is happening in this picture?" [$4 \times 2 = 8$] On the response space, write $4 \times 2 = 8$. For each of the other pictures, write on the response space the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through H. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 152

Workbook edition page 287

Basic facts: products and dividends of 10

The children study the multiplication and division basic facts for 10. They learn the standard name for the number named by each of the phrases 5×2, 2×5, $10 \div 2$, and $10 \div 5$.

The teaching suggestions given for page 149 (Wkbk, page 285) may be adapted for this page.

STA 2 page 153

Basic facts: products and dividends of 10

The children have studied all the multiplication and division basic facts for 10. Now they apply what they have learned.

The teaching suggestions given for page 150 may be adapted for this page.

STA 2 page 154

Basic facts: products and dividends of 6, 8, and 10; sums and minuends through 10

The children apply what they have learned about the basic facts with products and dividends of 10. They reinforce their learning of the basic facts studied so far.

The teaching suggestions given for page 148 may be adapted for this page.

Practice tablet page 130

Workbook edition page 238

Call attention to Picture A. Say: "What is the arithmetic sentence that tells what is happening in this picture? [10 ÷ 2 = 5] On the response space, write 10 ÷ 2 = 5. For each of the other pictures, write on the response space the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through U. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 155

Workbook edition page 239

Basic facts: products and dividends of 4 and 9

The children study the multiplication and division basic facts for 4 and 9. They learn the standard name for the number named by each of the phrases 2 × 2, 4 ÷ 2, 3 × 3, and 9 ÷ 3.

Through studying the basic facts with products and dividends of 6, 8, and 10, the children have become familiar with the general idea of multiplication and division basic facts. Now they are ready to study the facts for "special" situations. They should have no difficulty with learning the basic facts for 4 and 9.

The teaching suggestions given for page 149 (Wkbk, page 235) may be adapted for this page.

STA 2 page 156

Basic facts: products and dividends of 4 and 9

The children have studied all the multiplication and division basic facts for 4 and 9. Now they apply what they have learned.

The teaching suggestions given for page 150 may be adapted for this page.

STA 2 page 157

Basic facts: products, dividends, sums, and minuends through 10

The children apply what they have learned about the basic facts with products and dividends of 4 and 9. They reinforce their learning of the basic facts studied so far.

The teaching suggestions given for page 148 may be adapted for this page.

Practice tablet page 131

Workbook edition page 240

Call attention to Picture A. Say: "What is the arithmetic sentence that tells what is happening in this picture? [2 × 2 = 4] On the response space, write 2 × 2 = 4. For each of the other pictures, write on the response space the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through U. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 132

Workbook edition page 241

Say: "For each picture, write on the response space the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through V. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 139
Workbook edition page 242

Say: "For each picture, write in the response space the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through V. Tell the children that they are to complete each exercise by writing the correct numeral in the response space.

STA 2 page 139
Workbook edition page 242

Basic facts: products and dividends of 12

The children study the multiplication and division basic facts for 12. They learn the standard names for numbers named by phrases.

In presenting the basic facts for numbers greater than 10, the technique of grouping objects into a group of 10 and extra ones is again used. As a visual aid, a ring is shown around a group of 10. Thus the children can quickly "see," without counting, the ten and the extra ones and can recognize the total quickly.

Before beginning the work on this page, review the recognition of the numerousness of sets with 11 through 18 members.

Next direct attention to picture A. Use a procedure similar to the following: "Look at the first scene of picture A. Is the action a separating action or a combining action? How many sets of mice are there? Is the number of mice in each set the same? How many mice are in each set? Are all the sets of mice moving? What word or words can we use to describe the action? '2 twos' tells how many mice there are in all. What other phrases tell how many mice there are in all? Now we want to find the standard name for the number of mice.

"Look at the second scene of picture A. The same mice that were shown in the first scene are shown here. Can you tell, without counting, how many mice there are? What is there in the picture that helps you to see how many mice there are? How many mice are there? In the standard name for 2 × 12?"

Have various children read aloud the sentence given in picture A. On the chalkboard, write the following three sentences: 2 twos = 12; 2 × 2 = 12; 2 multiplied by 2 = 12. Have the children read each sentence aloud. Be sure they understand that 12 is the standard name for the number named by each phrase and that each sentence "fits" the situation pictured in A.

Adapt a similar teaching procedure for each of pictures B, E, and F. Each of these pictures illustrates a multiplication basic fact for 12.

After discussing pictures A and B, call attention to picture C. Ask questions similar to the following: "Look at the first scene in picture C. Can you tell, without counting, how many chickens there are? What is there in the picture that helps you? How many chickens are there? Now look at the second scene of picture C. The same chickens are shown in this scene. Is the action a combining action or a separating action? Is the number of chickens in each set the same? Are all the sets of chickens moving? What word or words can we use to describe this separating action? What phrase tells how many sets of chickens there are? Is 12 ÷ 6 a name for a number? 12 ÷ 6 is one name for the number that tells how many sets of chickens there are. Now we want to find the standard name for the number named by 12 ÷ 6.

"Look again at the second scene of picture C. How many sets of 6 chickens are there? Are '12 ÷ 2' and '6' names for the same number? What is the standard name for the number named by 12 ÷ 2?"

Call attention to the sentence given in C. Have various children read the sentence aloud. Be sure the children understand that 6 is the standard name for the number named by 12 ÷ 2 and that both "12 ÷ 2" and "2" tell how many equal subsets there are.

STA 2 page 159
Workbook edition page 244

Basic facts: products and dividends of 12

The children continue to study the multiplication and division facts for 12. For Pictures A and B, adapt the suggestions given for page 158 (Wkbk, page 243).

The children now apply what they have learned through the study of the basic facts for 12. The teaching suggestions given for page 150 of *STA 2* may be adapted for Pictures C, D, E, and F.

STA 2 page 160

Basic facts: products and dividends of 12

The children have studied all the multiplication and division basic facts for 12. Now they apply what they have learned.

The teaching suggestions given for page 150 may be adapted for this page.

Practice tablet page 134
Workbook edition page 245

Say: "For each picture you are to complete the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through U. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 135
Workbook edition page 246

Say: "For each picture you are to complete the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through V. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 161

Keeping skillful: sums, minuends, products, and dividends through 12

The children reinforce their learning of the addition, subtraction, multiplication, and division basic facts for the numbers 2 through 12.

As has been explained before, the purpose of the pages entitled "Keeping skillful" is twofold: to give the children practice that will help them reinforce previously taught skills and concepts, and to provide the teacher with a means of determining what reteaching should be done before proceeding further.

The exercises on this page provide a means of diagnosing general weakness in any or all of the processes. Responses to the exercises can also reveal how well the children can shift from one process to another and how well they understand the terminology of the basic facts.

The majority of the children should be able to do the work on this page independently. Tell them to read each exercise, decide what numeral replaces the placeholder, and then write the letter of the exercise and completed sentence on their papers. If you prefer, you can have the children read each sentence silently and then take turns giving the completed sentences orally.

Practice tablet page 136
Workbook edition page 247

Notice that this page consists of two blocks of exercises. Use your own judgment as to how many exercises to assign at one time.

Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 132

Checking up: lines, segments, points, and polygons; place value

The children are tested on their knowledge and understanding of the geometric ideas and ideas of place value studied so far.

The responses to the exercises on this page may be given orally, or they may be written. For the exercises concerning geometric ideas, the children are to use the diagram at the left in finding the response to an exercise.

If the responses to exercises A through L are to be given orally, have the children read an exercise silently, study the diagram, and decide upon the response. Then ask various children to read the exercise aloud and give their response. If the responses are to be written, have the children write the letter of an exercise and the response on their papers.

If the responses to the two blocks of exercises labeled A through J are to be given orally, have the children read an exercise silently and decide what numeral replaces each placeholder. Then ask various children to read the exercise aloud and give the response. If the responses are to be written, have each child write the letter of the exercise and the response on his paper.

Practice tablet page 137

Workbook edition page 248

Notice that this page consists of two blocks of exercises. Use your own judgment as to how many exercises to assign at one time.

Tell the children that they are to complete each exercise by writing the correct numeral in the response space.

STA 2 page 133

Workbook edition page 249

Keeping skillful: situations involving additive action and subtractive action -- sentences of the forms $3 + 2 = \square$, $6 - 4 = \square$, $\square + 2 = 5$, *and* $\square - 4 = 2$; *sums, minuends, products, and dividends through 12*

The children analyze and solve verbal problems that involve either additive action or subtractive action. They reinforce their learning of the basic facts that they have studied so far.

Most of the children may be able to do the work on this page independently. Tell them to read each problem and write the letter that labels it on their paper. Then, for each problem, they should write two sentences. The first sentence describes the problem situation and contains a placeholder. The second sentence contains the numeral that replaces the placeholder. For problem A, they should write the following:

A $1 + 6 = \square$ $1 + \square = 7$

Have the other children in the class who cannot work independently with the exercises on this page participate in activities similar to those you have been using for previous problem-solving pages. Have each problem read silently first. Next discuss the problem and help the children build the sentence that expresses the situation. Then have them write the mathematical sentence on their papers. Ask them to decide what numeral replaces the placeholder and to write the completed sentence. Have a child read the completed sentence aloud.

Exercises A through J (blue letters) may be used for oral or for written practice. Have the children take turns in reading the exercises. The children could respond orally, in turn, giving the sentence again with the correct numeral for the placeholder, or they could write the completed sentence on a sheet of paper. If the responses are to be written, supply the correct responses for the children so that they can verify their work.

FUNDAMENTAL OPERATIONS

This "Fundamental operations" section emphasizes two basic ideas: names for the same number and the relationship between multiplication and division.

On pages 164 and 165 (Wkbk, pages 250 and 251), the children study all the names for the numbers 1 through 12 that have been presented thus far.

Then they are given the opportunity to gain a better understanding of the relationship between multiplication and division. As with the addition and subtraction basic facts, the multiplication and division basic facts in *Seeing Through Arithmetic 2* are organized in such a way that the children become aware that there is a relationship between multiplication and division, although attention is not focused on this relationship when the basic facts are taught.

STA 2 pages 164 and 165
Workbook edition pages 250 and 251
Names for the same numbers [*extension*]

The children have learned to name a number by using either a standard name or a mathematical phrase. Now they observe all the phrases they have studied that are names for the numbers from 1 through 12. They also express relationships between numbers by using one of the phrases, "is less than," "is equal to," or "is greater than."

Before you begin work with these two pages, ask the children to think of names that they have learned for the number 6 (or any number through 12). Have each child write all the names he can think of.

Next write the numeral 6 on the chalkboard. Ask the children to give the names for 6 that they have written on their papers. Write these names on the chalkboard. Then have the children open their books to page 164 (Wkbk, page 250) and compare the list below the numeral 6 with the list on the chalkboard.

Have the children read the different names listed on the chart for each of the numbers from 1 through 12. As they read each phrase have them identify the standard name for the number named by the phrase.

Then direct attention to the exercises at the bottom of page 164 (Wkbk, page 250). Have the children read each sentence and determine the correct replacement for the screen. Then have various children read sentences aloud, supplying a standard name for a number as a replacement for the screen. Have other children in the class verify each response.

If more drill seems necessary, give names of numbers at random (for example, "four plus eight," "two times four," and so on), and ask the children to state the standard name for each number.

You can also have the children use markers to show various names for numbers from each of the lists.

For exercises A through X on page 165 (Wkbk, page 251), have the children read each exercise and select one of the phrases "is less than," "is equal to," and "is greater than" as a replacement for the wavy line. Then have a child read the completed sentence aloud. The other children should verify the correctness of the response.

Practice tablet page 138
Workbook edition page 252

Notice that this page consists of two blocks of exercises. Use your own judgement as to how many of these exercises you can assign at one time.

For Exercises A through V, tell the children that they are to complete each sentence by writing the correct numeral on the response space.

Before assigning Exercises A through L, direct attention to Exercise A. Say: "Is 10 − 4 greater than 8 ÷ 4? [Yes] Is 10 − 4 less than 8 ÷ 4? [No] Draw a line through the words *is less than*. Now the sentence

tells the truth about the numbers. $10 - 4$ and $6 + 4$. Complete each of the other exercises. Be sure that the sentence tells the truth about the numbers. Draw a line through the group of words that you do not use."

STA 2 page 106

Workbook edition page 200

Relationship between multiplication and division

The children learn that a divisive action that is expressed by such a phrase as $6 \div 3$ can be thought of as the "undoing" of a multiplicative action that is expressed by the phrase 3×2.

Each of the pictures on this page consists of three scenes: the first scene shows a multiplicative situation, the second scene shows the total group, and the third scene shows the divisive situation that is related to the multiplicative action pictured in the first scene. For each picture, the situation in the first scene suggests a combining action, and the situation in the third scene pictures the "undoing" of the combining action.

Direct attention to the first scene in picture A. Ask: "How many sets of chickens are shown? Is the action a separating action, or is it a combining action? How many chickens are there in each set? What numeral should we use as a replacement for the square screen in the phrase shown in the first scene?" Write on the chalkboard the phrase "3 × ■." Then have a child write on the chalkboard a completed phrase, supplying a numeral for the square screen. Have the other children verify the replacement. Ask: "Does 'three times two' tell what is happening in the first scene of picture A?"

For the second scene, ask: "How many chickens are pictured in the second scene? Does the second scene show that three sets of chickens, with two chickens in each set, have been combined into one set of six chickens?"

Then say: "Now look at the third scene. Is the action pictured a combining action, or is it a separating action? What words can we use to describe what is happening? (Divided by) How many chickens were there to begin with? How many chickens are there in each set that is moving away? Think of the replacement for the square screen in the phrase shown in the third scene." Write the phrase "6 ÷ ■ " on the chalkboard and ask a child to write on the chalkboard the completed phrase, supplying the replacement for the square screen. Have the other children verify the replacement.

Next have the children compare the first scene and the third scene. Ask questions that will help them discover that each of the subsets pictured in these scenes has the same number of members. The children should also discover that in the first and third scenes the number of subsets is the same and that the total number of chickens is the same in each scene. Say: "In the first scene, there are three sets. Each set contains two objects. The three sets of objects are combining into one set. We use the phrase 'three times two' to describe this action. In the third scene, a set of six objects is separating into different sets. Each set contains two objects. We use the phrase 'six divided by two' to describe this action. Can we think of 'six divided by two' as the 'undoing' of 'three times two'?"

Discuss pictures B, C, and D in a similar way. Have the children use markers to illustrate the situations pictured.

STA 2 page 107

Relationship between multiplication and division

The children continue to study the relationship between multiplication and division.

Use the pictures in alphabetical order. For each picture have the children determine whether the action pictured suggests a multiplicative situation or a divisive situation. (Pictures A, B, E, and G show multiplicative action.)

Direct attention to picture A. Have the children give the phrase that names the number

and describes the action (3 × 3), and then find a picture that shows the "undoing" of this and give its phrase (picture F, 9 ÷ 3).

Continue in this way for each picture that shows multiplicative action. (Picture I relates to picture D, picture C relates to picture E and picture B relates to picture G.) Lead the children to discover that there is no picture showing multiplicative action that relates to picture H, which shows divisive action.

Do not hurry the work on this page. Permit the children to use markers at their desks as much as they need to.

Practice tablet page 139
Workbook edition page 254

Direct attention to the first part of Picture A. Say: "Does this picture show a joining action or a separating action? [A joining action] What is the name for the number of clowns that tells what is happening? [2 × 3] Write 2 × 3 on the first response space. What is the standard name for 2 × 3? [6] Look at the second part of the picture. How many toy clowns are there? [6] Is the same number of clowns shown in each part of the picture? [Yes] In this part of the picture you are to show the action that undoes 2 × 3. Should this action be a joining action or a separating action? [A separating action] How many clowns should there be in each group? [3] Draw a ring around each group of 3. What is the name for the number of groups of clowns that tells what happened? [6 ÷ 3] Write 6 ÷ 3 on the response space in this part of the picture."

Tell the children to complete each of the other pictures in the same way.

RATE PAIRS

The idea of *relation* is of great mathematica significance. Children at the elementary level are not expected to know precisely what is meant by a mathematical relation. However, they can learn some of the many and varied applications of different mathematical relations. They can also begin to get an understanding of relations so that they will be prepared for a more thorough development in later grades.

Elementary mathematical relations involve a pair of numbers. In *Seeing Through Arithmetic 2*, the children begin to learn about the relations used for *comparison*. They learn to use a pair of numbers to describe how the number of objects in one set compares with the number of objects in another set, or how the number of objects in a subset compares with the number of objects in the set.

Making comparisons is a common experience in our everyday lives. Most of us spend a great deal of time comparing what we have, what we do, how long it takes us to do it, etc. with similar achievements of our friends. Newspapers and magazines often contain statistical data and illustrations using comparisons of all kinds. Learning to use and make comparisons is an accomplishment the children will have occasion to use the rest of their lives.

A comparative situation arises when two numbers are to be compared. Suppose, for example, that you have a set of 5 blocks. Two of the blocks are red and 3 of them are blue. If you compare the number of red blocks with the number of blue blocks, you can say, "There are 2 red blocks for each 3 blue blocks." If you compare the number of blue blocks with the number of red blocks, you can say, "The comparison of blue blocks with red blocks is 3 to 2." If you compare the blue blocks with all the blocks in the set, you can say, "3 blocks out of 5 are blue."

Notice that in the situations in which one number of blocks is compared with another number of blocks, a pair of numbers is used to make the comparison — 2 to 3; 2 for 3; 3 out of 5. Notice also that the numbers in each pair occur in a certain order. An ordered pair of numbers used in this way is a *rate pair*.

A rate pair is a mathematical idea. It is an ordered pair of numbers that is used to make a comparison. It is necessary to have some means of expressing the rate pair. A rate pair may be expressed by using a numeral for each number in the pair. We call this pair of numerals a *ratio*. Each of the following pairs of numerals is a ratio that names a particular rate pair: 3 to 4; 8 out of 5; 4 for 7; and 2/5 (read "two to five" or "two for five").

In grade 3, the children begin to develop the idea of rate pairs. They learn to make comparisons. They also learn to use ratios orally to describe each comparative situation.

Later in the *Seeing Through Arithmetic* program, the children will study other situations that involve rate pairs and that can be described by using ratios. For example, suppose 2 pieces of a certain kind of candy cost 4 cents. Then 6 pieces of this candy will cost 8 cents, 9 pieces will cost 12 cents, and so on. This situation involves the concept of *rate* and in this example the rate is "3 pieces for 4 cents" or, more simply, "3 for 4." Rate situations like this one are expressed by using ratios. The ratio "3 for 4" or "3/4" may be used to express the rate situation involving the pieces of candy. The children will also learn to write and read ratios that express rate pairs.

571 2 cups 195

Workbook edition page 255

Developing the meaning of rate pairs — use of expressions like "2 out of 3," "3 for 4," and "3 to 4"

The children begin to develop an understanding of rate pairs. They learn to use rate pairs to compare the number of objects in a subset with the number of objects in the set. They also learn to use rate pairs to compare the number of objects in one subset with the number of objects in another subset. They learn about the conditions under which they can make such statements as "2 blocks out of 3 are red," "3 small tops for each 2 large tops," and so on.

It is not necessary or desirable for you to use the words 'rate pairs' in talking with the children. Understanding should precede the introduction of a mathematical term.

Each picture on the page shows several sets of objects. In each picture the objects in the sets are alike (blocks in A, umbrellas in B, etc.). Furthermore, each set shown in a particular picture contains the same number of objects (3 blocks in each set for picture A, 5 drums in each set for picture C, etc.).

The children learn that when they use a physical characteristic, such as color, size, or shape, as the basis for determining subsets, this characteristic must be true for each set. Suppose that for Picture B, the number of green (Wkbk, blue) umbrellas is used as the basis for comparison. The children learn that they can use a rate pair to indicate the comparison of the number of green umbrellas with the number of umbrellas in the set because there are 2 green umbrellas in each set. However, suppose that the number of open umbrellas is used as the basis for comparison. The children learn that they cannot use a rate pair to indicate the comparison of the number of open umbrellas with the number of umbrellas in the set because there are not 2 open umbrellas in each set.

Sets of small objects of the same kind that differ physically in color, size, or shape, such as blocks, markers, pencils, crayons, toy cars, and so on, will be useful in teaching this lesson.

Let the children look at the pictures on the page and identify the objects. By using questions get them to see that, in each picture, there is the same number of objects in each set. Lead them to observe the differences and similarities of objects within a set. Do not emphasize the total number of objects in each picture.

Direct attention to picture A. Proceed with questions and directions such as the following: "How are the blocks arranged? How many blocks in each set are red (Wkbk, orange)? Can you say that 2 blocks out of each set of 3 blocks are red? Is there any other way in which the sets of blocks are alike?" (Work for responses like "There is 1 blue block in each set"; "1 block out of each set of 3 blocks is blue"; "1 out of 3 is blue"; "There is 1 blue block for each 2 red blocks"; "There are 2 red blocks for each blue block.")

"Now look at Picture B. How are the umbrellas arranged? How are the sets alike? What can you say about the sets of umbrellas? Is there any other way in which the sets of umbrellas are alike?"

Discuss the other pictures in a similar way. Be sure the children understand clearly that no characteristic should be selected as a common characteristic unless it is true of every set. For example, if the children notice that 2 tops in a set of 5 tops are large, they must be sure to check each set of 5 tops in the picture to see if it contains just 2 large tops before they can say "2 tops out of each 5 tops are large."

Pay special attention to the picture of the bells. No quantitative statement of the kind under consideration can be made by the children for this picture except that the bells are arranged in sets of 5. Some of the bells are brown (Wkbk, orange) and some of the bells are black (Wkbk, blue), but the number of each color is not the same in each set. Some children may want to say, "But there is at least 1 brown bell in each set." Try to get them to understand that although this is true, it is not the same kind of statement they have been making, because there are 1, 2, or 3 brown (Wkbk, orange) bells in each set.

After discussing the pictures, give each child a collection of 12 or 15 small objects, one third of which are different in size, color, or shape from the rest but similar to one another. Examples of appropriate collections are: 8 green cars and 4 yellow cars; 10 big markers and 5 little markers; 8 blue cards and 4 white cards; 10 pieces of white chalk and 5 pieces of yellow chalk. Ask the children to arrange their collections in sets of 3 in such a way that each set is exactly like every other set. Then let each child make statements about another child's arrangement: "1 car out of each 3 cars is yellow," "2 cars out of each 3 are green," "2 markers out of each 3 are big," and so on. If time permits, give the children other collections and have them arrange the objects in sets of 5.

Practice tablet page 140
Workbook edition page 256

Introduce the printed words *blue* and *white*.

Then direct attention to Picture A. Say: "How many baseballs are in each set? [4] How many baseballs in each set are blue? [3] How many baseballs in each set are white? [1] Are the sets alike? [Yes] Draw a ring around the word *yes*. Look at the first sentence. Are 3 out of 4 baseballs blue? [Yes] What numeral should you write on the first response space? [3] Write 3 on the first response space. What numeral should you write on the second response space? [4] Write 4 on the second response space. Look at the second sentence. Is 1 out of 4 baseballs white? [Yes] What numeral should you write on the first response space? [1] Write 1 on the first response space. What numeral should you write on the second response space? [4] Write 4 on the second response space.

"For each of the other pictures, decide if the sets are alike. If the sets are alike, draw a ring around the word *yes*, and complete the sentences by writing the correct numeral on each response space. If the sets are not alike, draw a ring around the word *no*."

Workbook edition

Developing the meaning of rate pairs — use of expressions like "2 to 3" and "3 for 4"

The children begin to develop an understanding of equivalent rate pairs. Equivalent rate pairs are rate pairs that represent the same comparison. They learn that each of the rate pairs 12 to 8, 3 to 4, and 6 to 8 represent the same comparison.

Direct attention to picture A. Ask: "How many tops are there? How many balls are there? What can we say to compare the number of tops with the number of balls?" (The children will probably give the statement "There are 12 tops for 8 balls." Lead them toward the use of "12 (or 8) and "12 to 8.") "What can we say to compare the number of balls with the number of tops?" (Again the children will probably say "There are 8 balls for 12 tops." Lead them to say "8 for 12" and "8 to 12.")

"There are other ways that we can compare the number of tops with the number of balls. We can regroup the tops and the balls. Look at picture B. How many tops are there in all? How many balls are there in all? Can we say that there are 12 tops for 8 balls? How are the tops arranged? [In 2 sets] How many tops are in each set? [6] How are the balls arranged? [In 2 sets] How many balls are in each set? [4] Are there 6 tops for each 4 balls? What can we say now to compare the number of tops with the number of balls? [6 to 4 or 3 for 4] When we compare the number of tops to the number of balls, we can say either '6 to 4' or '3 to 4.' What are the two ways we can compare the number of balls with the number of tops? [4 to 6 and 4 to 12]"

Adopt a similar procedure for pictures C, D, and E. For picture C, the children should discover that "6 to 4" represents the same comparison as "12 to 8" and "6 to 4" and that "3 to 2" represents the same comparison as "6 to 12" and "4 to 6." For picture D, they should observe that "4 to 4" does not represent the same comparison as "12 to 8" or "8 to 12" because the balls cannot be arranged so that there is a set of 4 balls for each set of 4 tops. For picture E, they should discover that "3 to 1" (or "1 to 2") does not represent the same comparison as "12 to 8" (or "8 to 12") because the tops cannot be arranged so that there are 3 tops for each ball.

The children should be given many opportunities to make comparisons involving the numbers of objects in sets. One suggested activity follows.

Give each child some objects of two kinds and a different quantity of each. Suggested combinations of objects are: 6 and 12, 8 and 12, 6 and 18, 10 and 20, 12 and 16, 12 and 20. Suppose you give each child 6 red markers and 12 blue markers and have them experiment to find how many ways they can compare the number of red markers with the number of blue markers. The children should discover that the rate pairs 6 to 12, 4 to 8, 3 to 6, 2 to 4, and 1 to 2 can represent the comparison of the number of red markers with the number of blue markers.

Practice tablet page 141
Workbook edition page 258

Direct attention to Picture A. Say: "How many bells are in each set? [1] How many marbles are in each set? [8] Is there a bell for each set of 8 marbles? [Yes] Is there a set of 8 marbles for each bell? [Yes] Draw a ring around the word *yes*. Look at the first exercise. Is there 1 bell to 8 marbles? [Yes] What numeral should you write on the first response space? [1] Write 1 on the first response space. What numeral should you write on the second response space? [8] Write 8 on the second response space. Look at the second exercise. Are there 8 marbles to 1 bell? [Yes] What numeral should you write on the first response space? [8] Write 8 on the first response space. What numeral should you write on the second response space? [1] Write 1 on the second response space."

Tell the children to work with each of the other pictures in the same way.

STA 2 page 170
Workbook edition page 259
Developing the meaning of rate pairs -- use of expressions such as "6 to 4" and "6 for 4"

The children continue to develop their understanding of rate pairs and to use rate pairs in comparison situations.

The jacks shown in pictures A through D should be used as the "master sets." The children will select the objects that can be compared with the jacks in each picture.

Let the children look at the page as a whole. Have them identify the objects in each picture. They should discover that each picture shows several sets and that each set has the same number of objects.

Direct attention to picture A. Say: "How are the jacks arranged? [In 3 sets] How many jacks are in each set? [4] We want to compare the number of jacks with the number of objects in another picture. Look at picture E. How are the balls arranged? [In 4 sets] How many balls are in each set? [2] Are there 4 jacks for each 2 balls? Can we compare the number of jacks with the number of balls? Why? [The jacks are not arranged so that there are 4 jacks for each 2 balls]"

Use a similar procedure for comparing picture A with pictures F through L. For picture H, the children should discover that they can compare the number of jacks with the number of whistles because there are 4 jacks for each 3 whistles. They should decide that they can say "4 to 3" to represent this comparison. Some children may discover that "12 to 9" also represents the comparison.

For picture I, the children should decide that "4 to 6" represents the comparison of the number of jacks with the number of marbles. Some children may say that "12 to 18" also represents the comparison.

Follow a similar procedure for comparing each of pictures B, C, and D with pictures E through L. The children should discover that they can compare the number of jacks in B with the number of blocks in G (6 to 5 or 12 to 10) and with the number of shells in J (6 to 7 and 12 to 14). They should discover that the number of jacks in C can be compared with the number of balls in E (3 to 2 and 12 to 8) and with the number of spools in K (3 to 4 and 12 to 16). They should compare the number of jacks in D with the number of trucks in F (2 to 1 and 12 to 6) and with the number of cars in L (2 to 3 and 12 to 18). Let the children use markers as they discuss the pictures.

As another activity, have the children compare the number of objects in each of pictures E through L with the objects in another picture. The number of balls may be compared with the number of spools, for example. Have them tell what rate pair represents the comparison.

Practice tablet page 142
Workbook edition page 260

Direct attention to Pictures A through D. For each picture, ask the children how many sets of marbles there are and how many marbles are in each set. Be sure that they observe that for a given picture, there is the same number of marbles in each set.

Then direct attention to Picture E. Say: "How many sets of blocks are there? [4] In which picture are there 4 sets of marbles? [Picture B] Write the letter B on the response space after the word *picture*. Look at the first exercise. How many blocks are in each set? [2] How many marbles are in each set in Picture B? [4] Are there 2 blocks to 4 marbles? [Yes] What numeral should you write on the first response space? [2] Write 2 on the first response space. What numeral should you write on the second response space? [4] Write 4 on the second response space. Look at the second exercise. Are there 4 marbles to

generalization that explains the 9 in the fourth step. Exercises B through I should be used for independent work. The children can use the work in exercise A as a pattern, but you should encourage them to work without using that exercise.

Practice tablet page 143
Workbook edition page 261

Notice that there are two blocks of exercises on this page. Use your own judgment as to how many exercises you can assign at one time.

Tell the children to complete each exercise by writing the correct letter or numeral on each response space.

ST4 2 page 172
Checking up: additive action and subtractive action — sentences of the forms $3 + 2 = \square$, $6 - 4 = \square$, $\square + 3 = 5$, *and* $\square - 3 = 2$; *sums, minuends, products, and dividends through 12*

The children are tested on their ability to analyze and solve verbal problems that involve either additive action or subtractive action. They are also tested on their knowledge of some of the basic facts that they have studied so far.

Ask the children to read each problem and write the letter that labels it on their papers. Then, for each problem, have them write two sentences. The first sentence should express the problem situation and contain a placeholder. The second sentence should contain the numeral that replaces the placeholder. For problem A, they should write the following:

A 11 − 4 = ■ 11 − 4 = 7

For each of exercises A through C, have the children read the exercise and decide what numeral replaces the placeholder. Then have them write the letter of the exercise and the completed sentence. For exercise A they would write:

A 7 + 4 = 11

Practice tablet page 144

Workbook edition page 262

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem, and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the number that replaces the screen. Be sure that you read each problem carefully, because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

MEASUREMENT

One activity in which mathematical ideas play an important part is measurement. Measurement is the process by which we determine a number (the *measure*) that is the *length*, the *area*, the *capacity*, and so on, of an object. The measure is determined by comparing the object with an established standard, or unit.

Every day children meet many measurement situations in their play, in their school work, and in their home activities. Thus it is important that children learn early how to measure.

Seeing Through Arithmetic 1 introduced the idea that some *unit* of measure is necessary and that any unit may be selected and used as a unit of measure. For example, to determine the length of an object, the unit of comparison may be a stick of any convenient length. This unit is then used to determine the length of the object.

The children went through several stages in grade 1 in learning to use a non-standard unit of measure. First, the children compared the object to be measured with the measuring unit being used and noted whether the object was longer, shorter, or about the same length as the measuring unit. Second, they compared the object to be measured with several models of the measuring unit, and then counted the individual units, thereby determining the length of the object in terms of the unit used. Third, the children used one model of the measuring unit repeatedly and counted the number of times the model was used, and in this way determined the length of the object in terms of the unit used. The children also learned to use such phrases as "more than" or "a little less than" in situations in which the unit did not appear to fit a "whole" number of times. It is important that the children become aware of the need for *standard units of measure*. A standard unit of measure is a definite unit agreed upon by a group of people (for example, a nation) and accepted for use as a model in obtaining a measure. *Seeing Through Arithmetic 2* introduces the inch, the foot, the pint, and the quart as conventional standard units of measure.

STA 2 page 173

Workbook edition page 263

Linear measurement -- inch as a standard unit

The children learn that the *inch* is a standard unit of measure. They compare objects such as line segments to the measuring unit (an inch) and note whether the objects are longer, shorter, or about the same length as the measuring unit. They also use models of the measuring unit applied repeatedly to measure the lengths of objects. Finally, they use a measuring stick marked at 1-inch intervals to determine the lengths of objects.

Begin by asking the children if they ever wonder how far away something is or how long something is. Let them tell about their experiences. Try to find out how they would go about measuring something. Someone may sug-

gest the use of a stick, or even a ruler or a measuring tape. If no one suggests a measuring unit, do not mention it until actual work in measurement begins.

Give each child a two-inch stick. Have available a set of objects each about two inches long. Let the children use the sticks to find the measure of the lengths of the objects by using the stick once in the measuring process. Explain that they must place the measuring stick alongside the object in such a way that one end of the stick is even with one end of the object. Also, the stick must be held so that it is "straight" alongside the object. Encourage them to express the lengths as a little longer, a little shorter, or the same length as the stick.

To teach the children how to find a measure of the length of an object by using the same measuring unit repeatedly, give each child a sheet of paper that has been ruled off in advance. The paper should be about eight inches wide. The first "line" and some of the others should extend the full width of the paper, and the "lines" should be about two inches apart.

Ask the children to use their sticks to find the length of the first "line." Lead them to discover that they need more sticks. Ask them if they can think of any way to determine the length (or measure) of the line, using just one stick. Let them discuss the problem until a child suggests using the same stick over and over. If necessary, help them by asking questions like these: "Could we use just one stick over and over?" How would we know how many times the stick has been put down? How would we know where to place the stick each time?"

Show the children how to determine the measure of the "line" by putting down the stick so that one end of the stick is at one edge of the "line," making a mark at the other end of the stick, and then putting the stick down again with the end of the stick touching the mark that has been made. Watch to see that they put the stick against the mark and keep the stick on the "line." Have them continue to move the stick and mark the paper. Then have them count the spaces between the marks to see how many times they put the stick down. They should express the measure by saying the ruled "line" is about three (or four, five, etc.) sticks long.

It is important for the children to understand that they cannot talk to each other intelligibly about lengths or distances unless everyone is using the same measuring unit.

Give various children sticks of various lengths. Have them determine the lengths of the same objects (for example, the ruled paper, or a book). Ask why one child says a book is two sticks long and another says it is five sticks long. Ask if they think that some of them did not measure correctly. Continue the discussion until the children show that they understand why it is necessary to use a common unit of measure if two measures are to be compared.

Provide each child with a 1-inch stick or piece of cardboard. Do not use inch squares as measuring "sticks" because the children may be confused about which side of the square to use. Introduce orally the word *inch*. Explain that each of their sticks is 1 inch long. Emphasize that the word "inch" is used by everyone because it always means the same length or distance.

Have the children open their books to page 173 (Wkbk, page 269), and compare their measuring sticks to the one-inch model shown at the top of the page and labeled "A".

Introduce the printed word *inch*. Explain that each of the blue-colored (Wkbk, grey-colored) units shown on this page is one inch long. Explain that the term "1-inch bar" will be used to talk about these units. Have them compare their measuring stick with the various 1-inch bars so that they are satisfied that the lengths are the same.

Next, have them compare the objects labeled B, C, D, and E with the 1-inch bars shown alongside each object. Call attention to the

fact that one end of the bar is even with one end of the object. They should say: "The eraser is less than one inch long; the paper clip is a little more than one inch long; the nail is less than one inch long; and the stick is one inch long."

Now have them work with the pictured objects that are labeled F, G, H, I, and J. Lead the children to discover that they must count each of the 1-inch bars in order to determine the measure of each object. Encourage them to give responses like these: "The whistle is two inches long; the candle is a little less than two inches long; the key is a little less than three inches long; the piece of peppermint candy is three inches long; and the paint brush is a little more than four inches long."

Discuss the pictures of the pencils at the bottom of the page. The children should understand that pictures K, L, and M show the same pencil. Have them determine the length of the pencil labeled K in the same way that they determined the length of the paint brush labeled J. They should say that the pencil is six inches long. For picture L explain that, instead of using 1-inch bars, we are using a colored strip of paper that has been marked off at intervals of one inch. Remind them that, in measuring the ruled paper, they used the idea of marking intervals of the same length. They should determine that the length of pencil L is six inches. Discuss the colored strip below pencil M. Point out that this strip is similar to the one below pencil L, except that the marks are not drawn across the strip. They should determine that the pencil is six inches long.

As an added activity, give each child a strip of tagboard or other heavy paper. Have them use their 1-inch measuring sticks to make marks on the strip at intervals of one inch. Then have them use the strip of paper to determine the lengths of various objects.

STA 2 page 174
Workbook edition page 264
Linear measurement -- the inch as a standard unit

The children learn to determine the length of an object by using measuring "strips" marked at intervals of one inch. They describe the length of the object by using such terms as "three inches long," "a little less than two inches long," and so on.

Let the children look at the page and describe what they see. They should observe that a measuring "strip" marked at 1-inch intervals is shown alongside each pictured object.

Have the children determine the length of each pictured object. Remind them that one end of the strip must be even with the end of the object. For each object, the children should first count the spaces on the measuring strip to determine its length. Then they should describe the length of the object by comparing it with the measuring strip. Help them by asking questions such as, "How long is the blue strip in picture A? How long is the wood screw in picture A?"

Practice tablet page 145
Workbook edition page 265

Provide each child with a 12-inch ruler marked only in inches.

Direct attention to Picture A. Say: "Use your ruler to find the length of the comb. Is the length of the comb 5 inches? [No] Is the length of the comb less than 5? [No] Is the length of the comb greater than 5? [Yes] Find the words *greater than*. Write 5 on the response space after the words *greater than*.

"For each of the other pictures, use your ruler to find the length of the object. Then, decide which response you should complete, and write the correct numeral on the response space."

Practice Tablet page 146

Workbook edition page 305

Provide each child with a 12-inch ruler marked only in inches.

Say: "For each of the pictures, use your ruler to find the length of the object. Then decide which response you should complete, and write the correct numeral on the response line."

STA 2 page 376

Workbook edition page 307

Linear measurement -- the inch as a standard unit; scale drawing

The children learn to determine the lengths of objects by using measuring sticks on which appear numerals that correspond to marks at 1-inch intervals.

This page consists of two parts. The top part of the page introduces the children to the idea of scale drawing. The bottom part of the page provides practice in determining lengths of objects. Notice that, except for pencil A, the objects on this page appear smaller than actual size.

Direct attention to the measuring stick below pencil A. Explain that the stick has been marked off at intervals (segments) of one inch. You could have them use their measuring strips to determine that the marks on the picture are an inch apart.

Say: "To find the length of an object with a measuring strip it is necessary to count the spaces on the measuring strip. How can the numerals on the measuring stick help you to find the length of the pencil?" The children should understand that when each mark on a measuring stick is labeled with a numeral, it is not necessary to count the spaces. Instead, to find the length of an object it is only necessary to read the numeral that corresponds to the mark nearest the end of the object.

Introduce orally the word "ruler." Explain that the measuring stick pictured below pencil A is a ruler. Say: "Look at the ruler. Point to the first mark. If you were making a ruler, explain how you would locate the first mark. (If necessary, remind them of their work in measuring the ruled paper.) How would you locate the second mark? What numeral is used as a label for the first mark? How long is the part of the ruler from the top of the left edge to the mark with the numeral 1? How long is the part of the ruler from the top of the left edge to the mark with the numeral 2? How long is the part of the ruler from the mark with the numeral 1 to the mark with the numeral 2?" Continue in this way. Work to ensure that the children understand that 1 is the interval (or segment) between two adjoining marks (or between the top of the left edge and the mark for the numeral 1) that represents one inch--not just a mark or a numeral that appears on the ruler.

Say: "Look at the left end of the pencil. Is the tip of the eraser even with the left edge of the ruler? Look at the right end of the pencil. Is the tip of the pencil even with the right edge of the ruler? Notice that the right edge of the ruler stands for a mark. What numeral labels this mark? How long is the pencil? Notice that, by using the pictured ruler, you found the length of pencil A without counting the spaces."

Ask the children if objects are always pictured in actual size. If convenient, have available two pictures that employ different scales but picture the same object (an automobile, for example). Let the children examine the pictures. Lead them to conclude that the same object is shown in both pictures even though the object appears "larger" in one of the pictures.

Have the children look at pictures A, B, and C. Explain that the pencil and the ruler in picture A are shown in actual size. Use statements and questions to help them understand that the same pencil and the same ruler are also shown in each of pictures B and C.

You might suggest to the children that they pretend that pictures B and C are photographs of the actual pencil and ruler. Although the pencil and the ruler are shown smaller than actual size in pictures B and C, they can use the pictures to determine the actual length of the pencil in B and in C.

For the pictures at the bottom of the page, have the children discuss the pictured objects and observe that they are shown in smaller size than the actual objects. Explain that the rulers shown are also pictured in smaller size. They should understand that they are to accept the pictured rulers as representing rulers marked at 1-inch intervals. Have them use the ruler pictured with each object to determine the length of the object.

For pictures F and H (the hammer and the pliers), call attention to the fact that the right end of the ruler is not used to determine the length of the objects. The children should say that the hammer is ten inches long and that the pliers are a little more than nine inches long.

Have the children look at the pictures of the wood dowel and the twelve-inch ruler at the bottom of the page. Have available some foot rulers to show the children. Introduce orally the word "foot." Explain that a measure of twelve inches is also called "one foot." Thus, the length of the dowel may be described as "12 inches long" or as "1 foot long." Refer again to the picture of the hammer. Ask: "Is the hammer 1 foot long? Is the hammer less than 1 foot long?"

Practice tablet page 147
Workbook edition page 268

Say: "Both the objects and the rulers on this page are smaller than actual size. For each picture, use the pictured ruler to find the length of the object. Then, decide which response you should complete, and write the correct numeral on the response space."

STA 2 page 176
Workbook edition page 269
Linear measurement -- the foot as a standard unit; relationship between inch and foot

The children learn that the length of an object that is 12 inches long may be described as being 1 foot long. They continue to determine the lengths of objects that are drawn to scale, but now they express these lengths in terms of feet.

If possible, have available for each child a 12-inch ruler marked only in inches. Also have available a number of objects that can be used to give the children practice in measuring.

Direct attention to the ruler pictured at the top of the page. Ask: "How long is the ruler in inches?" Remind the children that, although the picture of the ruler is not the actual size, they are to accept it as being a 12-inch ruler. Introduce the printed word "foot." Remind them that a length of 12 inches may also be described as being "1 foot long." Ask one of the children to read the sentence below the ruler. Then ask: "Is 12 inches as long as 1 foot?"

Give each child one of the foot rulers. Ask them why they think the word "foot" came to be used for this particular standard unit of measure. Say: "Suppose that each of two men determined the length of a room by putting his feet down heel to toe. [If necessary, demonstrate this technique for the children.] Explain why one man might say the distance was ten feet long while the other man might say the distance was eleven feet long."

Discuss again the need for standard units of measure. Explain that the word "foot" when used in measurement always means a particular length, and that this length can also be described by the phrase "12 inches long."

Refer again to the pictures of the rulers. Ask: "Does each picture represent the same kind of ruler? Remember that each ruler pictured is to be thought of as representing the same

length. Can we call each of the rulers a 12-inch ruler? Can we also call each of the rulers a 1-foot ruler?"

Refer to the pictures labeled A through G. Have the children describe what they see. Call attention to the fact that the objects are shown in smaller than actual size. Explain that the rulers alongside each object are also shown in smaller than actual size. Say: "Look at the broom. How many foot rulers are there alongside the broom? To describe the length of the broom we say the broom is 'five feet long.' We use the word 'feet' because we are talking about more than one foot. We use the word 'foot' when we are talking of just one foot."

Have the children describe the length of each of the pictured objects. (The saw is more than 2 feet long; the bat is a little less than 3 feet long; and so on.) Point out that in each picture one end of the pictured object is even with one end of the rulers that are laid end-to-end. Also point out that there are no gaps between these rulers.

Practice tablet page 148
Workbook edition page 270

Say: "Both the objects and the rulers on this page are smaller than actual size. For each picture, use the pictured ruler to find the length of the object. Then, decide which response you should complete, and write the correct numeral in the response space."

STA 2 page 177
Linear measurement -- judgment relating to precision

The children continue to determine lengths by using a 12-inch ruler that is marked only in inches.

This page provides two activities. In one activity, the children determine lengths of pictured segments. In the other activity, the children determine how far away specific marks are from a given starting position.

Provide each child with a ruler that is marked only in inches. For the activity that involves segments, direct attention to the segment labeled A. Have the children place their rulers alongside the pictured segment. Caution them to be sure that one end of the ruler is even with one end of the segment. Supervise the work closely. It is important that the children develop good habits of placing their rulers correctly and that they become aware of the need for care in this work.

Ask the children to determine the length of segment A. Since segment A is a little more than 7 inches long, accept responses such as "Segment A is about 7 inches long" or "Segment A is 7 inches long." Then have the children again determine the length of segment A, but this time have them begin by placing the end of the ruler at the other end of the pictured segment. They should discover that the length of the segment is the same when measured in this way. Follow a similar procedure with segments B through J.

In measuring some of the segments, the children will find that one end of the pictured segment will correspond to a position on the ruler that is about halfway between the inch marks. As an example, segment H is about $3\frac{1}{2}$ inches long. Encourage the children to say: "Segment H is a little more than 3 inches long" or "Segment H is a little less than 4 inches long."

The lengths of the other pictured segments are B - about 3 inches, or 3 inches; C - a little more than 2 inches; D - a little more than 4 inches, or a little less than 5 inches; F - about 4 inches, or 4 inches; I - about 6 inches, or 6 inches; G - a little more than 6 inches; E - about 4 inches, or 4 inches; J - about 2 inches, or 2 inches.

Next, direct attention to the marks on the yellow piece of paper. Call attention to the four kinds of marks (solid, broken, wavy, and with arrows) and the two starting positions

near the corners of the page (one orange, the other green).

Ask questions similar to the following: "What mark is 2 inches from the green starting position? How far from the orange starting position is the brown, broken mark? How far is the blue mark with arrows from the green starting position? How far is the green wavy mark from the orange mark with arrows?"

Continue this activity until you feel that the children can use their rulers with ease.

Practice tablet page 149
Workbook edition page 271

Provide each child with a 12-inch ruler marked only in inches.

Direct attention to Picture A. Say: "Use your ruler to find the length of the first blue stick. What is the length of this stick? [5 inches] Write 5 on the response space. Look at the second blue stick and the ruler that are smaller than actual size. What is the length of this stick? [5 inches] Do the two sticks have the same length? [Yes] Draw a ring around the word *yes*.

"For each of the other pictures, use your ruler to find the length of the first stick, and write the correct numeral on the response space. Then look at the second stick and the ruler that are smaller than actual size. Decide if the two sticks have the same length. If the sticks do have the same length, draw a ring around the word *yes*. If the sticks do not have the same length, draw a ring around the word *no*."

Practice tablet page 150
Workbook edition page 272

Provide each child with a 12-inch ruler marked only in inches.

Say: "For each picture, use your ruler to find the length of the first stick, and write the correct numeral on the response space. Then look at the second stick and the ruler that are smaller than actual size. Decide if the two sticks have the same length. If the sticks do have the same length, draw a ring around the word *yes*. If the sticks do not have the same length, draw a ring around the word *no*.

STA 2 page 178
Workbook edition page 273
Capacity -- the pint as a standard unit of measure; scale drawing

The children learn that the *pint* is a standard unit of measure for capacity. They also learn that containers having different shapes can each have a capacity of 1 pint.

Have available several pint containers (milk cartons, milk bottles, ice-cream cartons, etc.) and several containers that do not have a capacity of 1 pint. Also, have available quantities of pebbles, dried beans, corn, or similar materials that are suitable for classroom work in measuring. In teaching this page, do not try to distinguish between liquid and dry measure, but attempt to keep the discussion confined to measures of liquids, even though liquids are not used in measuring.

One way to introduce this page is to have a class discussion that will remind the children of the need for units of measure other than those used in measuring length. Guide the discussion away from measures of weight if these are suggested by some children.

You might say: "Suppose your mother is baking a cake and is using a recipe that tells her what to mix together. If the recipe calls for some milk, how does your mother determine how much milk to add? Does she use a ruler to measure the milk?" Generally, the children are familiar with terms such as pint, quart, and cup and will suggest these names in a class discussion pertaining to the measurement of liquids.

Have the children open their books to page 178 (Wkbk, page 273). Direct attention to the pictured pint container in A and explain that the milk carton is shown in actual size. Lead

the children to understand that a carton such as the one pictured holds a definite amount of milk when filled. Introduce the printed word "pint." Explain that pint is a standard unit of measure for liquids, just as inch is a standard unit of measure for length. Emphasize that the word "pint" means a definite amount of liquid and is a word that has the same meaning for everyone. The children should understand that the carton pictured in A is a pint container and that it holds 1 pint of milk when filled.

Call attention to the rulers. Have the children determine how tall the pint carton is. Then have them determine how wide it is. Say: "Suppose we used a camera and took a photograph of a milk carton. Would the picture of the carton be the same size as the actual carton? Does picture B look like a photograph of a milk carton? Is the carton pictured in B shown in actual size?" Work to get the children to accept the idea that the picture of the carton that is smaller than actual size is the same pint milk carton as shown in A. Be sure they understand that picture B shows a pint carton.

Discuss each of pictures C, D, and E. The children should understand that each picture shows a pint container that is smaller than actual size. Call attention to the word "pint" that appears on each container. Have the children read the word in discussing each picture. The children should understand that each picture represents a container that holds the same amount of liquid and that the word "pint" describes the amount of liquid.

Use pint containers that are different in appearance to help the children understand that a measure of 1 pint is not necessarily determined by the shape of a container. Have various children fill these containers with cooking beans, corn, and so on. Explain that they are to think of the dried materials as representing a liquid. Then have other children pour the contents of one kind of pint container into another kind of pint container, so that they can observe that the containers hold the same amount.

STA 2 page 176

Workbook edition page 274

Capacity — the pint and the quart as standard units of measure; relationship between pint and quart

The children learn that a *quart* is a standard unit of measure for capacity and that "1 quart is as much as 2 pints." They also learn that containers of various shapes can have a measure of 1 quart.

The collection of materials and pint containers used in the preceding lesson will be useful again here. Also have available various quart containers.

Two teaching sequences are given on this page. Pictures A through D introduce the quart as a standard unit of measure for capacity. Pictures E through I can be used to help children understand that containers of various shapes can have a measure of a pint or a quart and that the measure of the container does not depend on the shape of the container.

Ask the children if they know any words that describe measures greater than a pint. Most children of this age are familiar with the words "quart" and "gallon." Focus the discussion on the quart as a measure of capacity. Ask the children to suggest things that are measured in quarts. Some of the things they might mention are milk, vinegar, motor oil, and fruit juices.

Direct attention to Picture A on page 179 (Wkbk, page 274). Explain to the children that the empty pitcher represents a quart container. Introduce the printed word "quart." Then call attention to the small containers and identify the liquid as orange juice. Ask the children to identify the word that appears on each container. Ask: "How many pint containers are there?" Tell them to imagine that they are going to pour the orange juice from the pint containers into the quart pitcher.

Have the children look at picture B. Explain that the orange juice in one of the pint containers has been poured into the pitcher. Ask: "How much orange juice is in the pitcher? How much orange juice is not in the pitcher? How many full pint containers are shown?"

Next, refer to picture C. Ask: "How much juice is in the large pitcher? What is happening? How much juice is being poured into the pitcher?"

Then have the children look at picture D. Ask: "How many pint containers are shown in the picture? Are these the same pint containers that are shown in picture A? What has happened to the orange juice in the pint containers? How many pints of juice are in the pitcher? Is there as much juice in the pitcher as there was in 2 pint containers? Are there 2 pints of juice in the pitcher? Instead of saying that there are 2 pints of juice, we can say that there is 1 quart of juice. 1 quart of juice is as much as 2 pints of juice." Have various children read the sentence "1 quart is as much as 2 pints." Ask: "Are 2 pints as much as 1 quart?"

For picture E, first have the children observe that each container is a pint container and that each container is filled with liquid. Identify the liquid as grape juice. Ask: "How many containers are there? Are they all pint containers? How much grape juice is in all the containers?" Have the children pretend that they have 7 pints of grape juice, as shown in picture E, and that they are going to pour the juice into the various containers shown in pictures F, G, H, and I. For each picture, ask questions such as: "What word is shown on each container? How much does each container hold? How many pints of grape juice will be needed to fill the first container? How many pints of grape juice will be needed to fill the second container [and so on]? Do you have enough grape juice to fill all the containers shown in the picture? Do you need more grape juice to fill the containers? If so, how much? Do you have some grape juice left over? If so, how much?"

You may also use pictures F, G, H, and I as follows: "Susan, suppose you have enough grape juice to fill the containers in picture G. How much do you have? Debbie, suppose you have enough grape juice to fill the containers in picture I. How much do you have? John, which girl has more grape juice?"

Continue to provide opportunities for the children to measure actual quantities and to compare amounts determined by measurements.

As an added activity, have the children compare the differences in appearance between various quart containers. Direct attention to the printed word "quart" if it appears on the container.

The work with pictures should be supported and enriched by measuring with actual quart and pint bottles and jars. Let the children use the quart and pint containers and the measuring material available to prove to their own satisfaction that one quart is as much as two pints.

Practice tablet page 151
Workbook edition page 275

Say: "There are three columns of pictures on this page. For each column, first decide how much the blue containers hold. For each of the other pictures in the column, decide if the white containers will hold an amount equal to, less than, or greater than the amount the blue containers hold. Then, draw a ring around the correct group of words."

Practice tablet page 152
Workbook edition page 276

Say: "There are three columns of pictures on this page. For each column, first decide how much the blue containers hold. For each of the other pictures in the column, decide if the white containers will hold an amount equal to, less than, or greater than the amount the blue containers hold. Then, draw a ring around the correct group of words."

STA 2 page 180
Workbook edition page 277
Capacity — the pint and the quart as standard units of measure

The children learn to measure capacity by using one copy of a quart or a pint unit of measure several times in a given situation. Then they decide which of the quantities measured is more than (or less than) the other quantity.

Have available 3 or 4 pint units of measure, 3 or 4 quart units of measure, and several large containers such as those shown in Pictures B, D, F, and H. The materials used for measuring in the preceding lessons (corn, beans, etc.) will be useful again here.

For the first picture of each sequence have the children describe what they see. Lead them to conclude that they cannot tell which container holds more because the containers are of different sizes and shapes. For the second picture, point out that a standard unit of measure (a pint in pictures B, D, and F; a quart in picture H) has been used to empty the contents of both containers into a large container. The tally marks show the number of times the measuring unit was used in emptying each container. Ask how much liquid was held by each of the containers. Then ask which container holds more (or less). Finally, ask the children to state how much the large container now holds.

The work with pictures should be enriched by using actual containers and measuring with a pint or a quart container. Partially fill two large containers with material to be measured. Ask the children to guess which container holds the greater amount. Then have various children use a pint container to determine the capacity of each of the large containers. Emphasize that in each case the measuring unit used must hold 1 pint. Have the children carefully record the number of times the pint container is used in emptying each large container. First ask how much each of the large containers holds; then ask which of the large containers holds more.

Repeat the activity as time permits with other large containers and quart measuring units. Let as many children participate in the activities as possible.

Practice tablet page 153
Workbook edition page 278

Say: "Look at the top part of Picture A. The tally marks tell you that you are to fill and empty this cup 8 times. Now look at the bottom part of the picture. How many times do the tally marks tell you to fill and empty this cup? [5 times] Can you tell from which cup you will empty more water? [Yes. The cups are the same size, but I will use the bottom cup a greater number of times.] From which cup will you empty more water? [The bottom cup] Draw a ring around the word *yes* beside the bottom cup.

"For each of the other pictures, decide if you can tell from which container you will empty more water. If you can tell, draw a ring around the word *yes* beside the container from which you will empty more water. If you cannot tell, draw a ring around the question mark. Remember that the tally marks tell you how many times you are to fill and empty each container."

STA 2 page 181
Workbook edition page 279
Capacity — judgment relating to precision

The children learn to discriminate in two kinds of situations. In one kind of situation it is possible to tell whether a quantity is greater (or less) than another quantity, and in the other it is not possible to do so.

Have available several pint and several quart containers of various shapes. Also have available several jars, glasses, cups, and boxes of various shapes and sizes. The material used for measuring in preceding lessons (corn, beans, etc.) may be used.

Discuss the pictures on the page in alphabetical order. Explain that each of the containers shown on this page has been filled. For each picture in which it is possible to do so, have the children determine how much is held by the containers in each row. Then ask them to determine, if possible, which row of containers (the top row or the bottom row) holds more. For each of pictures A and D they should discover that the containers in the top row hold as much as those in the bottom row. For picture C, they should decide that the containers in the bottom row hold more than those in the top row. For picture F, help them to understand that the large container shown in each row holds the same amount. Therefore, they should decide that the containers in the top row hold more than those in the bottom row. For each of pictures B and E, they should observe that some standard units of measure and some containers that are not standard units are shown. For these pictures, they should decide that they cannot determine which row of containers holds more.

Use the containers and materials described previously to establish situations similar to those pictured on this page. Let the children take turns in making judgments, giving reasons for their decisions, and measuring quantities to prove their statements.

Practice tablet page 154
Workbook edition page 280

Tell the children that all the containers on this page are filled. Then say: "Look at Picture A. Can you tell which group of containers holds a greater amount? [Yes] Which group of containers holds a greater amount? [The bottom group] Draw a ring around the word *yes* beside the bottom group of containers.

"For each of the other pictures, decide if you can tell which group of containers holds a greater amount. If you can tell, draw a ring around the word *yes* beside the group of containers that holds the greater amount. If you cannot tell, draw a ring around the question mark."

CHECKING UP

The tests on pages 182 through 185 may be used as end-of-year tests. These tests may be used diagnostically to reveal the extent of the child's knowledge of the concepts taught in the second grade. These are power tests, not speed tests. Give only as many tests in one period as you can reasonably expect your class to complete successfully.

Test 1, page 182, covers the four types of problem situations studied in this book.

Test 2, page 182, and test 3 on page 183 cover the addition basic facts with sums of 4 through 12.

Tests 4 and 5, page 183, cover the subtraction basic facts with minuends of 4 through 12.

Test 6, page 183, includes addition and subtraction basic facts with sums and minuends of 2 through 12.

Test 7, page 184, covers the multiplication basic facts with products of 4, 6, 8, 9, 10, and 12.

Test 8, page 184, covers the division basic facts with dividends of 4, 6, 8, 9, 10, and 12.

Test 9, page 184, covers the ideas of "one greater than," "one less than," and betweenness for numbers.

Test 10, page 184, covers the ideas of "greater than," "less than," and "equal to."

Test 11, page 185, covers the geometric concepts studied.

Test 12, page 185, covers the idea of place value with two-digit numerals and with three-digit numerals.

Test 13, page 185, covers equivalent values for coins and for measures.

STA 2 page 183

Checking up: situations involving addition action and subtraction action — sentences of the forms 3 + 2 = ■, 6 − 4 = ■, ■ + 2 = 5, and ■ − 4 = 2; addition basic facts with sums through 12

The children are tested on their ability to analyze and to solve verbal problems that involve either addition or subtractive action. They also are tested on their knowledge of the addition basic facts with sums through 12.

Test 1 includes all the types of verbal problems studied during the year. Remind the children to think about each problem carefully to "see" what is happening before they write the sentence that expresses the problem situation. Results on this achievement test will give you a good overall picture of how well the children understand both problem solving and the building of sentences that express action situations.

Tell the children to write on their papers the letters that identify the problems in Test 1. Then, for each problem, have them read the problem and write two sentences. The first sentence expresses the problem situation and includes a placeholder. The second sentence contains the numeral that replaces the placeholder and indicates the answer to the question in the problem. For problem A, they should write the following:

A. 9 − 3 = ■ 9 − 3 = 6

For test 2A, have the children write the letters from A through F on their papers.

Then have them read each sentence, decide what numeral replaces the screen, and write the completed sentences beside the appropriate letters.

STA 2 page 184

Checking up: addition and subtraction basic facts with sums and minuends through 12

The children are tested on their understanding and knowledge of addition and subtraction basic facts with sums and minuends through 12.

Before beginning each of the tests on this page, have the children write the letters from A through J on their papers. Remember that all these tests need not be administered during one session. Remember also that these are power tests, not speed tests. Give only as many tests as you can reasonably expect your class to complete successfully.

For each test, have the children read each sentence, decide what numeral replaces the square screen, and write the completed sentences.

STA 2 page 184

Checking up: multiplication and division basic facts; ideas of "greater than," "less than," "equal to," and betweenness for numbers

The children are tested on their knowledge of multiplication and division basic facts with products and dividends through 12. They also are tested on their understanding of ideas of "greater than," "less than," "equal to," and betweenness for numbers.

For each of tests 7 and 8, have the children write the letters from A through E on their papers. Then have them read each sentence, decide what numeral replaces the screen, and write the completed sentence.

For test 9, have the children write the letters from A through I in a column. Then have them read each sentence, decide what numeral replaces the screen, and write this numeral beside the appropriate letter.

For test 10, have the children write the letters from A through G in a column. Direct attention to the groups of words printed above the exercises, and have a child read each group of words aloud. Explain that the children are to determine which of these three groups of words correctly replaces the wavy line in each exercise. Then have them read each exercise silently, determine which group of words replaces the wavy line, and write the completed sentence.

STA 2 page 185

Checking up: lines, points, segments, and polygons; place value; equivalent values for money and for measures

The children are tested on their knowledge and understanding of geometric ideas concerning lines, points, segments, and polygons. They also are tested on their knowledge and understanding of place value and equivalent values.

Direct attention to test 11. Explain that the children will need to refer to the first diagram to discover the information that is needed to complete exercises A through G. Tell them that they should study the second diagram to determine the facts necessary to complete exercises H through K. Be sure to point out that, for some of the exercises, more than one response should be given. Encourage the children to answer each exercise as completely as possible.

Use your own judgment as to the length of the written answer required for each exercise. For exercise A, as an example, you may simply have the children write the letters that name the points; for exercise F, you may have them write only the pairs of letters that name the segments.

For test 12, have the children write the letters from A through J in a column. Tell them that they should read an exercise silently, determine what numeral replaces the square screen, and write the numeral beside the letter that identifies the exercise. Then they should decide what numeral replaces the round screen and write that numeral on the same line after the numeral they have just written. For exercise A, they should write the following:

A 3 7

For test 13, have the children write the letters from A through I in a column. Then have them read each sentence, decide what numeral or word replaces the placeholder, and write the replacement beside the appropriate letter.

Practice tablet page 155

Workbook edition page 281

Say: "Read Exercise A. Use the picture to find your response. Write your response on the response space. Do each of the other exercises in the same way. For some of the exercises, you will not use all the response spaces."

Practice tablet page 156

Workbook edition page 282

Notice that this page consists of two tests. Use your own judgment as to how many tests to assign at one time.

Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 157

Workbook edition page 283

Notice that this page consists of two tests. Use your own judgment as to how many tests to assign at one time.

Tell the children that they are to complete each exercise by writing the correct numeral on each response space.

Practice tablet page 158

Workbook edition page 284

Notice that this page consists of four tests. Use your own judgment as to how many tests to assign at one time.

Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 159

Workbook edition page 285

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the

sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Practice tablet page 100
Workbook edition page 88

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

EXTENSION

This section of *Seeing Through Arithmetic 2* provides additional learning experiences that may be used to care for individual differences. It is recommended that this section be used only with abler children who master the basic work for grade 2 in less than the allotted time.

The basic facts presented in this section complete the addition and subtraction basic facts. Those with sums and minuends of 13 through 18 are introduced. The multiplication and division basic facts with products and dividends of 14, 15, 16, and 18 are also introduced. The children continue to solve verbal problems expressed by sentences of the forms 3 + 2 = ▥, 6 − 4 = ▥, ▥ + 2 = 5, and ▥ − 4 = 2.

The basic facts presented in this section are retaught in *Seeing Through Arithmetic 3.*

STA 2 page 186
Workbook edition page 287
Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 187).

STA 2 page 187
Workbook edition page 288
Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 187).

STA 2 page 188
Workbook edition page 289
Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 187).

STA 2 page 189
Adapt the teaching suggestions given for *STA 2* page 118.

Practice tablet page 161
Workbook edition page 290
Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

STA 2 page 190
Workbook edition page 291
Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 187).

STA 2 page 191
Workbook edition page 292
Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 187).

STA 2 page 192
Workbook edition page 293
Adapt the teaching suggestions given for *STA 2* page 123 (Wkbk, page 196).

STA 2 page 193
Adapt the teaching suggestions given for *STA 2* page 118.

Practice tablet page 162
Workbook edition page 294
Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the

sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

STA 2 page 194
Workbook edition page 295

Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 197).

STA 2 page 196
Workbook edition page 296

Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 197).

STA 2 page 198

Adapt the teaching suggestions given for *STA 2* page 114.

Practice tablet page 199
Workbook edition page 297

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

STA 2 page 197
Workbook edition page 299

Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 197).

STA 2 page 198

Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 197).

STA 2 page 199

Adapt the teaching suggestions given for *STA 2* page 114.

Practice tablet page 200
Workbook edition page 301

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the

screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

Practice tablet page 166
Workbook edition page 302

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

STA 2 page 200
Workbook edition page 303

Adapt the teaching suggestions given for *STA 2* page 114 (Wkbk, page 187).

STA 2 page 201
Workbook edition page 304

Adapt the teaching suggestions given for *STA 2* page 123 (Wkbk, page 196).

STA 2 page 202

Adapt the teaching suggestions given for *STA 2* page 118.

Practice tablet page 167
Workbook edition page 305

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully because some of the problems are about joining action and other problems are about separating action."

Either before the children begin to work, or after they have completed Problems A through F, direct attention to Exercises A through V. Say: "You are to complete each exercise by writing the correct numeral on the response space."

STA 2 page 203

For Exercises A through P (red letters), Exercises A through P (green letters), and Exercises A through V (blue letters), adapt the teaching suggestions given for *STA 2* page 161. For Exercises A through I (brown letters), adapt the teaching suggestions given for the last block of exercises on *STA 2* page 171.

Practice tablet page 168
Workbook edition page 306

Notice that this page consists of two blocks of exercises. Use your own judgment as to how many exercises to assign at one time.

Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 204
Workbook edition page 307

Adapt the teaching suggestions given for *STA 2* page 158 (Wkbk, page 243).

STA 2 page 205
Workbook edition page 308
Adapt the teaching suggestions given for *STA 2* page 158 (Wkbk, page 243).

STA 2 page 206
Adapt the teaching suggestions given for *STA 2* page 159.

STA 2 page 207
Adapt the teaching suggestions given for *STA 2* page 157.

Practice tablet page 169
Workbook edition page 309
Say: "For each picture you are to complete the arithmetic sentence that tells what is happening in the picture."
Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through U. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 170
Workbook edition page 310
Say: "For each picture you are to complete the arithmetic sentence that tells what is happening in the picture."
Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through V. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 208
Workbook edition page 311
Adapt the teaching suggestions given for *STA 2* page 158 (Wkbk, page 243).

STA 2 page 209
Workbook edition page 312
Adapt the teaching suggestions given for *STA 2* page 159 (Wkbk, page 244).

STA 2 page 210
Adapt the teaching suggestions given for *STA 2* page 157.

Practice tablet page 171
Workbook edition page 313
Say: "For each picture you are to complete the arithmetic sentence that tells what is happening in the picture."
Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through U. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 172
Workbook edition page 314
Say: "For each picture you are to complete the arithmetic sentence that tells what is happening in the picture."
Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through V. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 211
Workbook edition page 315
Adapt the teaching suggestions given for *STA 2* page 158 (Wkbk, page 243).

STA 2 page 212
Workbook edition page 316
Adapt the teaching suggestions given for *STA 2* page 108 (Wkbk, page 243).

STA 2 page 213
Adapt the teaching suggestions given for *STA 2* page 160.

STA 2 page 214
Adapt the teaching suggestions given for *STA 2* page 157.

Practice tablet page 173
Workbook edition page 317

Say: "For each picture you are to complete the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through U. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 174
Workbook edition page 318

Say: "For each picture you are to complete the arithmetic sentence that tells what is happening in the picture."

Either before the children begin to work, or after they have completed their work with the pictures, direct attention to Exercises A through V. Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

STA 2 page 215

Adapt the teaching suggestions given for *STA 2* page 183.

Practice tablet page 175
Workbook edition page 319

Notice that this page consists of four tests. Use your own judgement as to how many tests to assign at one time.

Tell the children that they are to complete each exercise by writing the correct numeral on the response space.

Practice tablet page 176
Workbook edition page 320

Say: "Read each problem carefully and think about what is happening in the problem. Next, make a sentence that describes the problem and write this sentence on the first response space. Use a screen to hold the place for the number you are to find. Then, on the second response space, write the sentence with the numeral that replaces the screen. Be sure that you read each problem carefully, because some of the problems are about joining action and other problems are about separating action.

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Date Due

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JUL 1 4	RETURN		
[illegible]			
FEB 2	5 RETURN		

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TCH=GD= PT=2
SEEING THROUGH ARITHMETIC

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